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The Choice of the Subjects at the University Level

The first choice of the student is due to family tradition. A doctor's child will try to get Medicine and that of an engineer will go for Engineering or at least this will be the ambition. Persons who immensely like literature in English, Sanskrit and Indian languages will choose English because of career opportunities. The choice of science subjects and research is because of job opportunities and possibility of growth by joining the great research laboratories.

Whatever may be the choice of the science subject, chemists can grow better in the research laboratories "dedicated" to that branch. The word "dedicated" is put in quotes because in every laboratory, research opportunities are given for every subject because all of them have every instrument which is the same plus some extra ones which are special for particular laboratories. The hottest choice today for the students of higher studies is Physics. This is because the subjects like atomic energy, space research and development of rockets and missiles and national laboratories not only have job opportunities but they also give satisfaction of getting associated with great things. Many of the subjects are learnt in the higher research institutions where every research is multifaceted.

When we read that Physics is the hottest choice of the students this year, we can answer you that whatever science subject you choose, you will find that your research group has many scientists who are as much mathematicians as chemists or physicists. There is no division of subjects in science in the higher levels. For recreation and inspiration, one can read the history of scientists. Whatever may be your choice, we wish you all the best.

Anil Ahlawat

Editor

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CHEMISTRY MUSING

Chemistry Musing was started from August '13 issue of Chemistry Today with the suggestion of Shri Mahabir Singh. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / AIPMT / AIIMS / Other PMTs & PETs with additional study material.

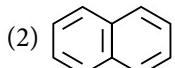
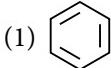
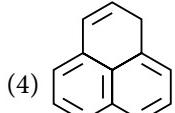
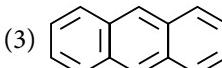
In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / AIPMT. The detailed solutions of these problems will be published in next issue of Chemistry Today.

The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue.

We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

PROBLEM Set 22

JEE MAIN/PMTs

1. 1 mol of ferric oxalate is oxidised by x mol of MnO_4^- and also 1 mol of ferrous oxalate is oxidised by y mol of MnO_4^- in acidic medium. The ratio $\frac{x}{y}$ is
 - (a) 2 : 1
 - (b) 1 : 2
 - (c) 3 : 1
 - (d) 1 : 3
2. Arrange the following molecules in increasing order of σ to π bond ratio.


 - (a) (2) < (3) < (4) < (1)
 - (b) (2) < (4) < (3) < (1)
 - (c) (3) < (2) < (1) < (4)
 - (d) (2) < (3) < (1) < (4)
3. The complex $[\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{2+}$ is formed in the ring-test for nitrate when freshly prepared FeSO_4 solution is added to aqueous solution of NO_3^- followed by addition of conc. H_2SO_4 . This complex is formed by charge transfer in which
 - (a) Fe^{2+} changes to Fe^{3+} and NO^+ changes to NO
 - (b) Fe^{2+} changes to Fe^{3+} and NO changes to NO^+
 - (c) Fe^{2+} changes to Fe^+ and NO changes to NO^+
 - (d) no charge transfer takes place.

4. To aqueous solution of NaI , increasing amounts of solid HgI_2 is added. The vapour pressure of the solution
 - (a) decreases to a constant value
 - (b) increases to a constant value
 - (c) increases first and then decreases
 - (d) remains constant because HgI_2 is sparingly soluble in water.
5. Which of the following sets of reagents, used in the order shown, would enable the preparation of *p*-chlorophenol from *p*-chloronitrobenzene?

(a) 1. Fe , HCl ;	2. NaOH ;
3. NaNO_2 , H_2SO_4 ;	4. H_3PO_2
(b) 1. Fe , HCl ;	2. NaOH ;
3. NaNO_2 , H_2SO_4 ;	4. H_2O , heat
(c) 1. Fe , HCl ;	2. NaOH ;
3. NaNO_2 , H_2SO_4 ;	4. ethanol
(d) 1. NaOH , heat;	2. HCl

Solution Senders of Chemistry Musing

SET 21

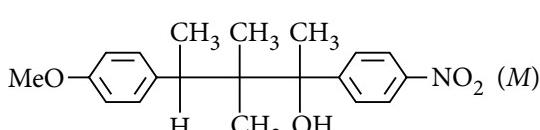
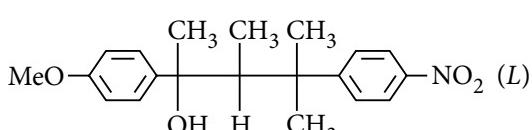
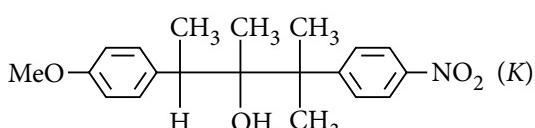
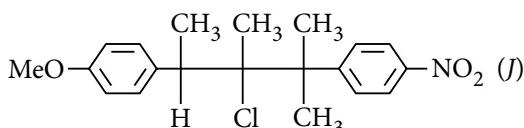
1. Krunal N. Jariwala (Ahmedabad)
2. Sarvesh Singh, Ghazipur (Uttar Pradesh)

SET 20

1. Shubhneet Shivam (Ambala)
2. Kashish (Haryana)

JEE ADVANCED

6. The compound (J) on hydrolysis in presence of aqueous acetone gives mainly



- (a) mixture of K and L
 (b) M only
 (c) mixture of K and M
 (d) K only.

COMPREHENSION

0.16 g of methane was subjected to combustion at 27°C in a bomb calorimeter. The temperature of the calorimeter system (including water) was found to rise by 0.5°C. The thermal capacity of the calorimeter system is 17.7 kJ K⁻¹.

7. The heat of combustion of methane at constant volume is

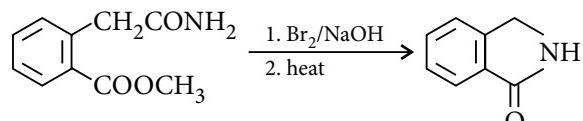
- (a) 885 kJ mol⁻¹ (b) -885 kJ mol⁻¹
 (c) 889.98 kJ mol⁻¹ (d) -889.98 kJ mol⁻¹

8. The heat of combustion of methane at constant pressure is

- (a) -889.98 kJ mol⁻¹ (b) 889.98 kJ mol⁻¹
 (c) -880.91 kJ mol⁻¹ (d) 880.91 kJ mol⁻¹

INTEGER VALUE

9. In the given reaction, number of methanol molecules eliminated is



10. The highest oxidation state exhibited by a transition element is



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PAPER-I

SECTION-1

One or More Than One Options Correct Type

This section contains 10 multiple choice type questions. Each question has four choices (a), (b), (c) and (d) out of which ONE or MORE THAN ONE are correct.

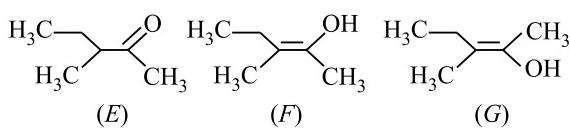
- The pair(s) of compounds which cannot exist together in aqueous solution is (are)
 - NaH_2PO_4 and Na_2HPO_4
 - NaOH and NaH_2PO_4
 - Na_2CO_3 and NaHCO_3
 - NaHCO_3 and NaOH
 - Reduction of the metal centre in aqueous permanganate ion involves
 - 3 electrons in neutral medium
 - 5 electrons in neutral medium
 - 3 electrons in alkaline medium
 - 5 electrons in acidic medium.
 - Which of the following statements is correct?
 - α -decay produces isodiapheres.
 - β -decay produces isobars.
 - $^{11}_6\text{C}$ shows positron emission.
 - $^{24}_{11}\text{Na}$ shows β -emission.
 - The correct statement(s) concerning the structures E , F and G is (are)

(E)

(F)

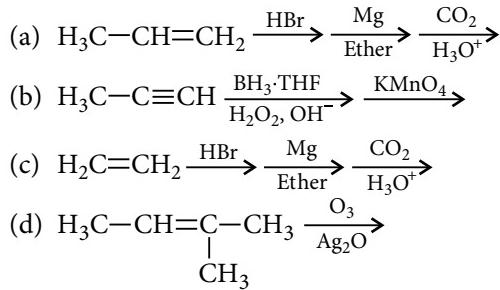
(G)

 - E , F and G are resonance structures
 - E , F and E , G are tautomers
 - F and G are geometrical isomers
 - F and G are diastereomers.
 - Which of the following are correct methods for the preparation of propanoic acid?

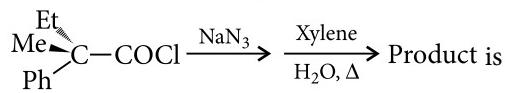


- (a) E , F and G are resonance structures
 - (b) E , F and E , G are tautomers
 - (c) F and G are geometrical isomers
 - (d) F and G are diastereomers.

5. Which of the following are correct methods for the preparation of propanoic acid?



- 6.** Consider the following reaction :

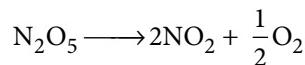


- (a)  (b) 

(c)  (d) 

7. Energy of which of d -orbital(s) is/are decreasing when $[M(CN)_6]^{3-}$ octahedral complex is changed to $[M(CN)_4]^-$ square planar complex?

8. The decomposition of nitrogen pentoxide is a first-order reaction,



If the rate of this reaction is given by

$$-\frac{d[N_2O_5]}{dt} = \frac{1}{2} \frac{d[NO_2]}{dt} = 2 \frac{d[O_2]}{dt} = k_1[N_2O_5]$$

then

$$-\frac{d[\text{N}_2\text{O}_5]}{dt} = k_1[\text{N}_2\text{O}_5]$$

$$+\frac{d[\text{NO}_2]}{dt}=2k_1[\text{N}_2\text{O}_5]=k'_1[\text{N}_2\text{O}_5]$$

$$+\frac{d[\text{O}_2]}{dt} = \frac{1}{2} k_1 [\text{N}_2\text{O}_5] = k'_1 [\text{N}_2\text{O}_5]$$

Choose the correct option.

- (a) $k_1 = 2k'_1 = k''_1$ (b) $2k_1 = k'_1 = 4k''_1$
 (c) $4k_1 = 2k'_1 = k''_1$ (d) $k_1 = k'_1 = k''_1$

9. Which of the given reactions is(are) correct?

- (a) $\text{H}_3\text{C}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H} \xrightarrow{\text{OH}^-} \text{H}_3\text{C}-\text{CH}=\text{CH}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H}$
- (b) $\text{Ph}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H} \xrightarrow{\text{KOH}} \text{Ph}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\bar{\text{O}}\text{K}^+ + \text{Ph}-\text{CH}_2-\text{OH}$
- (c) $\text{Ph}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H} \xrightarrow{\text{Al(OEt)}_3} \text{Ph}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{O}-\text{CH}_2-\text{Ph}$
- (d) $\text{H}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{H} \xrightarrow{\text{NaOH}} \text{H}-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-\text{OH} + \text{CH}_3\text{OH}$

10. For the reduction of NO_3^- ion in an aqueous solution, E° is + 0.96 V. E° values for some metal ions are given below :

- $\text{V}_{(\text{aq})}^{2+} + 2e^- \rightarrow \text{V}; E^\circ = -1.19 \text{ V}$
 $\text{Fe}_{(\text{aq})}^{3+} + 3e^- \rightarrow \text{Fe}; E^\circ = -0.04 \text{ V}$
 $\text{Au}_{(\text{aq})}^{3+} + 3e^- \rightarrow \text{Au}; E^\circ = +1.40 \text{ V}$
 $\text{Hg}_{(\text{aq})}^{2+} + 2e^- \rightarrow \text{Hg}; E^\circ = +0.86 \text{ V}$

The pair(s) of metals that is(are) oxidised by NO_3^- in aqueous solution is(are)

- (a) V and Hg (b) Hg and Fe
 (c) Fe and Au (d) Fe and V

SECTION-2

One Integer Value Correct Type

This section contains 10 questions. Each question, when worked out will result in one integer from 0 to 9 (both inclusive).

11. Silver (atomic weight = 108 g mol⁻¹) has a density of 10.5 g cm⁻³. The number of silver atoms on a surface of area 10^{-12} m² can be expressed in scientific notation as $y \times 10^x$. The value of x is

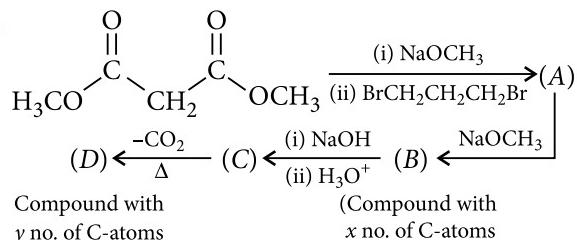
12. The number of moles of acidified KMnO_4 required to convert one mole of sulphite ion into sulphate ion is $\frac{x}{y} \cdot (x+y)$ is

13. When an inorganic compound reacts with SO_2 in aqueous medium it produces (A). (A) on reaction with Na_2CO_3 gives compound (B) which with sulphur gives (C), which is used in photography. The number of π bonds in (C) is

14. 0.2 M NaNO_3 and 0.1 M $\text{Ca}(\text{NO}_3)_2$ solutions are mixed in the ratio of $x:y$ such that in the resulting

solution, the concentration of anions is 50% greater than that of cations. The value of $x+y$ is

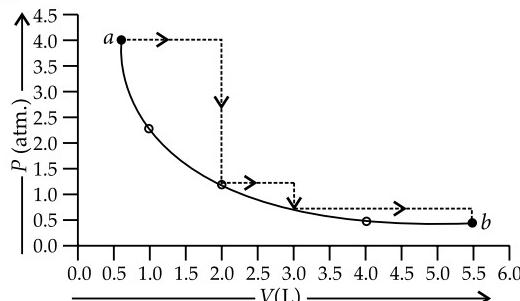
15.



In the above sequence of reactions, $(x-y)$ is

16. To 8.4 mL H_2O_2 , excess of acidified solution of KI was added. The iodine liberated required 20 mL of 0.3 N $\text{Na}_2\text{S}_2\text{O}_3$ solution. Volume strength of H_2O_2 solution is

17. One mole of an ideal gas is taken from a to b along two paths denoted by the solid and the dashed lines as shown in the graph below. If the work done along the solid line path is w_s and that along the dotted line path is w_d , the integer closest to the ratio w_d/w_s is



18. An organic compound (A) fumes in moist air and reacts with cold water to give an acid (B). Acid (B) reacts with NH_3 to give an amide (C). (C) on heating with P_2O_5 gives propane nitrile. The number of acyclic functional isomers of (A) is

19. 0.15 mole of pyridinium chloride has been added into 500 cm³ of 0.2 M pyridine solution. The pH is (K_b for pyridine = 1.5×10^{-9} M)

20. An aromatic hydrocarbon (A) $\text{C}_{16}\text{H}_{16}$ shows following reactions :

- (i) It decolourizes both Br_2 in CCl_4 and cold aq. KMnO_4 .
 (ii) It adds an equimolar amount of H_2 .
 (iii) Oxidation with KMnO_4 gives a dicarboxylic acid (B) $\text{C}_6\text{H}_4(\text{COOH})_2$ which gives only one monobromo substitution product.

The number of stereoisomers of the compound (A) is

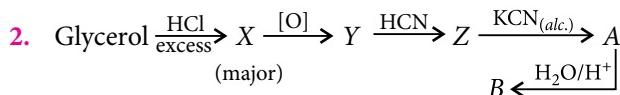
SECTION-1

Only One Option Correct Type

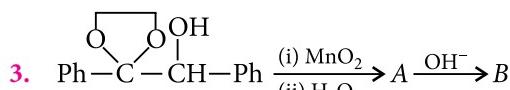
This section contains 10 multiple choice questions. Each question has four choices (a), (b), (c) and (d) out of which ONLY ONE option is correct.

1. One mole of nitrogen gas at 0.8 atm takes 38 seconds to diffuse through a pinhole whereas 1 mole of an unknown compound of xenon with fluorine at 1.6 atm takes 57 seconds to diffuse through the same hole. The molecular weight of the compound is

(a) 252 g mol^{-1} (b) 225 g mol^{-1}
(c) 207 g mol^{-1} (d) 223 g mol^{-1}



'B' is



Identify the product *B* in the reaction

- (a) 

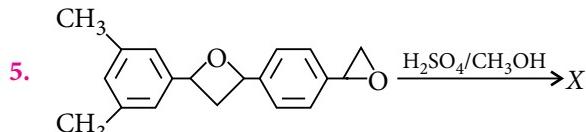
(b) 

(c) 

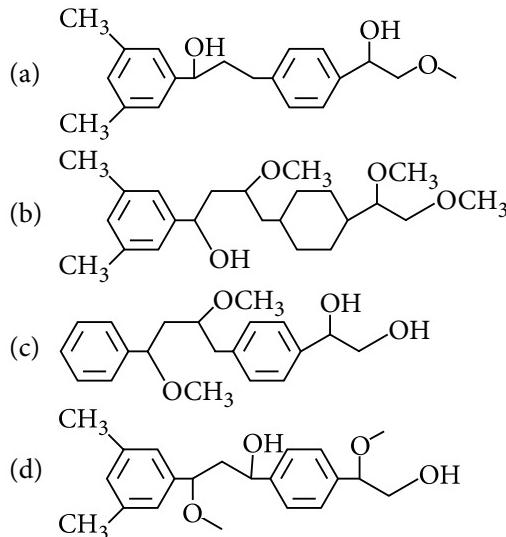
(d) 

4. Consider an ideal gas that occupies 2.5 dm^3 at a pressure of 3.0 bar. If the gas is compressed isothermally at a constant pressure p_{ext} , so that the final volume is 0.5 dm^3 , calculate the smallest possible value of p_{ext} and the work done using p_{ext} .

(a) 20 bar and 100 J (b) 15 bar and 3000 J
(c) 30 bar and 150 J (d) 10 bar and 375 J

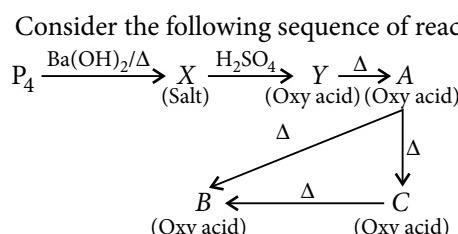


Identify X in the reaction.



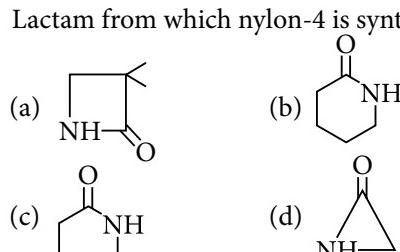
6. An aqueous solution containing a mixture of copper (II), iron (II) and lead (II) ions was treated with an excess of aqueous ammonia.
What precipitate was left by this reaction?
(a) Copper (II) hydroxide only
(b) Iron (II) hydroxide only
(c) Lead (II) hydroxide only
(d) Lead (II) hydroxide and iron (II) hydroxide only

7. In the reaction, $\text{Al} + \text{Fe}_3\text{O}_4 \longrightarrow \text{Al}_2\text{O}_3 + \text{Fe}$
Total number of electrons transferred during the change is
(a) 22 (b) 24 (c) 5 (d) 6



In the above sequence of reactions Y, A and B are respectively :

- (a) H_3PO_2 , H_3PO_4 , HPO_3
 (b) H_3PO_4 , $\text{H}_4\text{P}_2\text{O}_7$, HPO_3
 (c) H_3PO_4 , HPO_3 , $\text{H}_4\text{P}_2\text{O}_4$
 (d) H_3PO_3 , H_3PO_4 , H_3PO_2



10. de Broglie wavelength (in Å) of electron accelerated through V volt is nearly given by

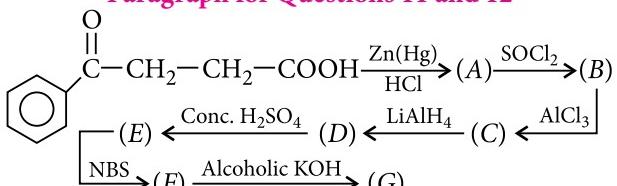
(a) $\left(\frac{150}{V}\right)^2$ (b) $\frac{150}{V}$
 (c) $\left(\frac{150}{V}\right)^{1/3}$ (d) $\sqrt{\frac{150}{V}}$

SECTION-2

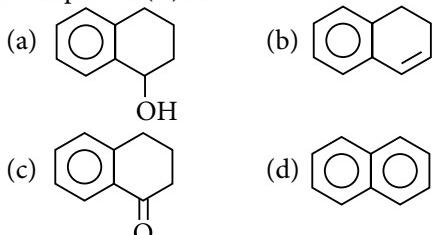
Comprehension Type (Only One Option Correct)

This section contains 3 paragraphs, each describing theory, experiments, data etc. Six questions relate to the three paragraphs with two questions on each paragraph. Each question has only one correct answer among the four given options (a), (b), (c) and (d).

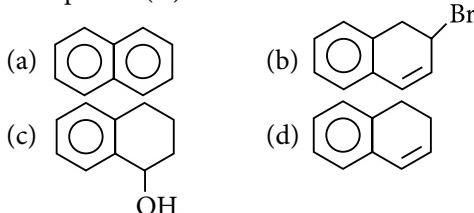
Paragraph for Questions 11 and 12



11. Compound (C) is



12. Compound (G) is



Paragraph for Questions 13 and 14

For a single electron atom or ion the wave number of radiation emitted during the transition of electron from a higher energy state ($n = n_2$) to a lower energy state ($n = n_1$) is given by the expression,

$$\bar{v} = \frac{1}{\lambda} = R_H \cdot Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \quad \dots(\text{i})$$

where $R_H = \frac{2\pi^2 mk^2 e^4}{h^3 c}$ = Rydberg constant for H-atom

where the terms have their usual meanings.

For Lyman series $n_1 = 1$ (fixed for all the lines) while $n_2 = 2, 3, 4, \dots$ for successive lines i.e., 1st, 2nd, 3rd ... lines, respectively. For Balmer series : $n_1 = 2$ (fixed for all the lines) while $n_2 = 3, 4, 5 \dots$ for successive lines.

13. The ratio of the wave numbers for the highest energy transition of electron in Lyman and Balmer series of H-atom is

(a) 4 : 1 (b) 6 : 1 (c) 9 : 1 (d) 3 : 1

14. If proton in H-nucleus is replaced by positron having the same mass and same charge as that of proton, then considering the nuclear motion, the wave number of the lowest energy transition of He^+ ion in Lyman series will be equal to

(a) $2R_H$ (b) $3R_H$ (c) $4R_H$ (d) R_H

Paragraph for Questions 15 and 16

Nitin and Deepak were given mixture of Al^{3+} , Cr^{3+} , Fe^{3+} , Zn^{2+} , Ni^{2+} , Co^{2+} and Mn^{2+} ions as their soluble salts which were not interfering radicals. They performed the experiment as follows :

Nitin : In the aqueous solution of ions he added first NH_4Cl then NH_4OH and then passed H_2S gas. He got the precipitate (X).

Deepak : In the aqueous solution of ions he first added NH_4Cl and then NH_4OH . He got the precipitate (Y) and a filtrate. In the filtrate, he passed H_2S gas and again got a precipitate (Z).

15. Precipitate (Y) when treated with aqueous Na_2O_2 solution, gives a yellow colour solution due to formation of

(a) ZnO (b) Na_2CrO_4
 (c) $\text{Na}_2\text{Cr}_2\text{O}_4$ (d) Fe(OH)_3

16. When precipitate (Z) is dissolved in acetic acid and then treated with NaBiO_3 in HNO_3 , a purple colour (P) solution is obtained. Which of the following is incorrect about (P)?

(a) (P) is a peroxy acid.
 (b) Potassium salt of (P) is used in redox titrations.
 (c) Potassium salt of (P) cannot be used to titrate Mohr's salt in presence of HCl or HNO_3 .
 (d) Potassium salt of (P) is a self indicator in redox titrations.

SECTION-3

Matching List Type (Only One Option Correct)

This section contains four questions, each having two matching lists. Choices for the correct combination of elements from List-I and List-II are given as options (a), (b), (c) and (d) out of which one is correct.

17. Match the List-I with List-II and select the correct answer using the code given below the lists :

List-I

- (P) XeF_4
 (Q) XeF_6
 (R) XeO_3
 (S) XeO_4

List-II

1. Distorted octahedral
 2. Tetrahedral
 3. Square planar
 4. Trigonal pyramidal

Code :

P	Q	R	S
(a) 3	1	4	2
(b) 3	1	2	4
(c) 2	1	4	3
(d) 1	2	4	3

18. Match the List-I with List-II and select the correct answer using the code given below the lists :

List-I

- | | |
|---------------------------------------|---------------------|
| (P) Decarboxylation of sodium acetate | 1. Ethyne |
| (Q) Wurtz reaction | 2. 2-Methylpropane |
| (R) Corey House reaction | 3. <i>n</i> -Butane |
| (S) Dehydrohalogenation | 4. Methane |

Code :

P	Q	R	S
(a) 3	1	2	4
(b) 4	3	2	1
(c) 1	2	3	4
(d) 3	1	4	2

19. Match the List-I with List-II and select the correct answer using the code given below the lists :

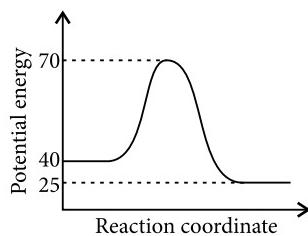
List-I

- | | |
|---|--|
| (P) $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ | 1. $(\text{CH}_3\text{CH}_2)_2\text{C=O}$ |
| $\xrightarrow{\text{PCC}}$ | |
| (Q) $\text{C}_6\text{H}_5\text{CH}_3$ | 2. CH_3COCH_3 |
| $\xrightarrow{\text{CrO}_2\text{Cl}_2}$ | |
| (R) $\text{CH}_3\text{COCl} + (\text{CH}_3)_2\text{Cd}$ | 3. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$ |
| $\xrightarrow{\quad}$ | |
| (S) $(\text{CH}_3\text{CH}_2\text{COO})_2\text{Ca}$ | 4. $\text{C}_6\text{H}_5\text{CHO}$ |
| $\xrightarrow{\Delta}$ | |

Code :

P	Q	R	S
(a) 1	2	3	4
(b) 3	2	1	4
(c) 2	1	3	4
(d) 3	4	2	1

20. Look at the following diagram and match the List-I with List-II and select the correct answer using the code given below the lists :



List-I

- | | |
|---|-----------------------------|
| (P) Activation energy of forward reaction | 1. 70 kJ mol^{-1} |
| (Q) Threshold energy | 2. 30 kJ mol^{-1} |
| (R) Activation energy for backward reaction | 3. 15 kJ mol^{-1} |
| (S) Enthalpy change of the reaction | 4. 45 kJ mol^{-1} |

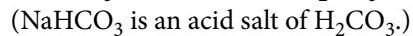
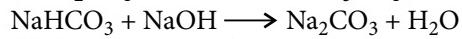
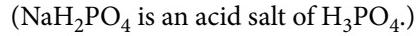
Code :

P	Q	R	S
(a) 3	1	2	4
(b) 1	2	3	4
(c) 2	1	4	3
(d) 4	3	2	1

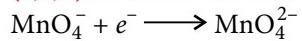
SOLUTIONS

PAPER-I

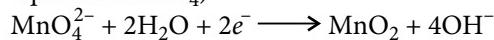
1. (b,d): $2\text{NaOH} + \text{NaH}_2\text{PO}_4 \longrightarrow \text{Na}_3\text{PO}_4 + 2\text{H}_2\text{O}$



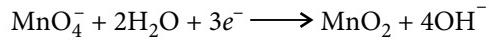
2. (a,c,d): In alkaline medium,



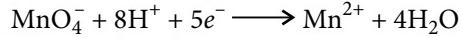
But MnO_4^{2-} is further reduced to MnO_2 (in case of aqueous KMnO_4)



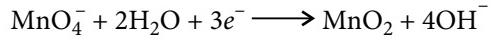
The resultant reaction is



In acidic medium,

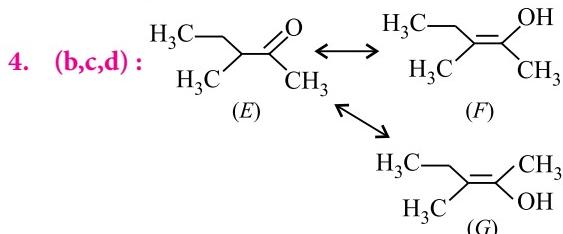
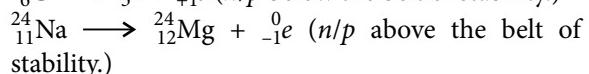
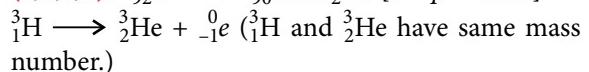


In neutral medium,



Hence, the number of electrons involved in the reduction of metal centre in aqueous MnO_4^- ion in neutral, alkaline and acidic media are 3,3 and 5 respectively.

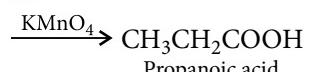
3. (a,b,c,d): ${}^{235}\text{U} \longrightarrow {}^{231}\text{Th} + {}^4\text{He}$ [$n - p = \text{same}$]



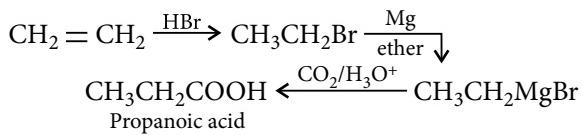
E - F and E - G are tautomers to each other.

F and G are geometrical isomers as their methyl groups can be *cis* and *trans* to each other. Also, all geometrical isomers are diastereomers of each other.

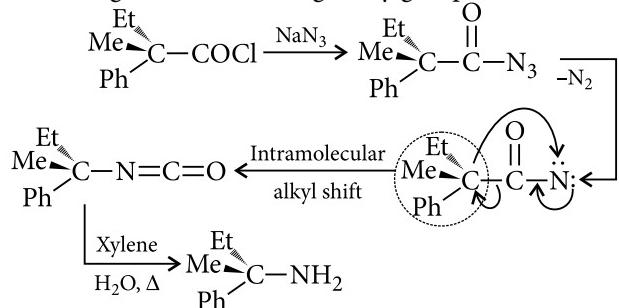
5. (b,c) : $\text{CH}_3\text{C} \equiv \text{CH} \xrightarrow[\text{H}_2\text{O}_2, \text{OH}^-]{\text{BH}_3\text{-THF}} \text{CH}_3\text{CH}_2\text{CHO}$



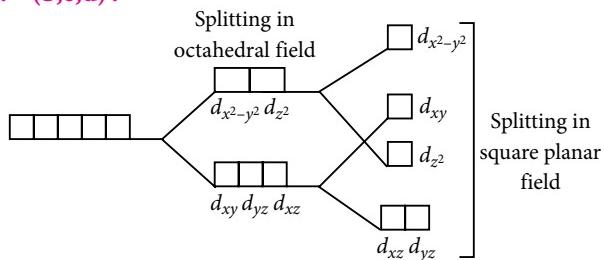
Propanoic acid



6. (a): Curtius rearrangement involves retention of configuration of the migratory group. Thus,



7. (b,c,d):



$$8. (\text{b}): -\frac{d[\text{N}_2\text{O}_5]}{dt} = \frac{1}{2} \frac{d[\text{NO}_2]}{dt} = 2 \frac{d[\text{O}_2]}{dt}$$

$$k_1[\text{N}_2\text{O}_5] = \frac{1}{2} k'_1[\text{N}_2\text{O}_5] = 2k''_1[\text{N}_2\text{O}_5]$$

$$\text{or } k_1 = \frac{1}{2} k'_1 = 2k''_1 \text{ or } 2k_1 = k'_1 = 4k''_1$$

9. (a,b,c)

10. (a,b,d): The substances which have lower reduction potentials are strong reducing agents while those which have higher reduction potentials are strong oxidising agents.

$\because E_{M^{n+}/M}^{\circ}$ for V, Fe and Hg are lower than that of NO_3^- , so NO_3^- will oxidise V, Fe and Hg.

11. (7): Given, atomic weight = 108 g mol⁻¹

Density = 10.5 g cm⁻³, Surface area = 10^{-12} m²

$$\text{Volume of one silver atom} = \frac{4}{3}\pi r^3$$

$$\therefore \text{Density} = \frac{\text{Mass}}{\text{Volume}} \Rightarrow \text{Volume} = \frac{\text{Mass}}{\text{Density}}$$

$$\text{or } \frac{4}{3}\pi r^3 = \frac{108}{6.023 \times 10^{23} \times 10.5}$$

$$r^3 = \frac{108 \times 3}{6.023 \times 10^{23} \times 10.5 \times 4 \times 3.14}$$

$$r^3 = 4 \times 10^{-24} \text{ cm}^3$$

$$\text{or } r = 1.58 \times 10^{-8} \text{ cm}$$

No. of silver atoms on a surface area of 10^{-12} m², can be given by,

$$10^{-12} = \pi r^2 \times n$$

$$n = \frac{10^{-12}}{3.14 \times (1.58 \times 10^{-8})^2} = 0.127 \times 10^8$$

$$\Rightarrow n = 1.27 \times 10^7 = y \times 10^x \text{ or } x = 7$$

$$12. (7): 2\text{MnO}_4^- + 6\text{H}^+ + 5\text{SO}_3^{2-} \longrightarrow$$

2 moles 5 moles

$$2\text{Mn}^{2+} + 5\text{SO}_4^{2-} + 3\text{H}_2\text{O}$$

5 moles of SO_3^{2-} \equiv 2 moles of MnO_4^-

1 mole of SO_3^{2-} \equiv $\frac{2}{5}$ moles of MnO_4^-

$$\text{Thus, } \frac{x}{y} = \frac{2}{5}$$

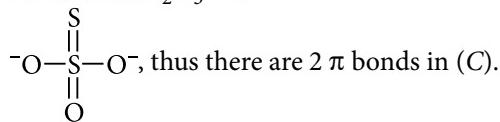
$$x + y = 2 + 5 = 7$$

$$13. (2): \text{Na}_2\text{CO}_3 + 2\text{SO}_2 + \text{H}_2\text{O} \longrightarrow 2\text{NaHSO}_3 + \text{CO}_2 \quad (\text{A})$$

$$2\text{NaHSO}_3 + \text{Na}_2\text{CO}_3 \longrightarrow 2\text{Na}_2\text{SO}_3 + \text{H}_2\text{O} + \text{CO}_2 \quad (\text{B})$$

$$\text{Na}_2\text{SO}_3 + \text{S} \longrightarrow \text{Na}_2\text{S}_2\text{O}_3 \quad (\text{C})$$

Structure of $\text{S}_2\text{O}_3^{2-}$ is



14. (3): Let V_1 mL of NaNO_3 is mixed with V_2 mL of $\text{Ca}(\text{NO}_3)_2$.

Millimoles of NaNO_3 mixed = $0.2 \times V_1$

Millimoles of $\text{Ca}(\text{NO}_3)_2$ mixed = $0.1 \times V_2$

\therefore Molarity of NO_3^- in mixture

$$= [\text{NO}_3^-] \text{ (from } \text{NaNO}_3) + [\text{NO}_3^-] \text{ (from } \text{Ca}(\text{NO}_3)_2)$$

$$= \frac{0.2 \times V_1}{(V_1 + V_2)} + \frac{0.1 \times 2 \times V_2}{(V_1 + V_2)}$$

$$= \frac{0.2 \times V_1 + 0.2 \times V_2}{(V_1 + V_2)} \quad \dots(\text{i})$$

Molarity of Na^+ and Ca^{2+} ions in mixture

$$= \frac{0.2 \times V_1}{(V_1 + V_2)} + \frac{0.1 \times V_2}{(V_1 + V_2)} = \frac{0.2V_1 + 0.1V_2}{(V_1 + V_2)} \quad \dots(\text{ii})$$

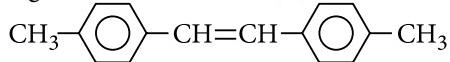
Since the concentration of anions is 50% greater than that of cations,

$$\therefore \frac{0.2V_1 + 0.2V_2}{(V_1 + V_2)} = \frac{3}{2} \left[\frac{0.2V_1 + 0.1V_2}{(V_1 + V_2)} \right]$$

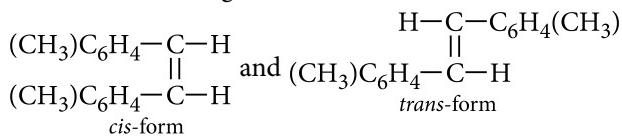
$$\Rightarrow \frac{V_1}{V_2} = \frac{x}{y} = \frac{1}{2} \quad \therefore x = 1, y = 2$$

$$\text{So, } x + y = 3$$

keeping in view above facts, (A) is



(A) also shows geometrical isomerism,



PAPER-II

- 1. (a):** Given : $P_1 = 0.8 \text{ atm.}$, $P_2 = 1.6 \text{ atm.}$, $t_1 = 38 \text{ s.}$,
 $t_2 = 57 \text{ s.}$, $M_1 = 28 \text{ g mol}^{-1}$, $M_2 = ?$

From Graham's law of diffusion, $\frac{r_1}{r_2} = \frac{P_1}{P_2} \sqrt{\frac{M_2}{M_1}}$

For diffusion of same number of moles of gases,

$$\frac{t_2}{t_1} = \frac{P_1}{P_2} \sqrt{\frac{M_2}{M_1}}$$

$$\Rightarrow \frac{57}{38} = \frac{0.8}{1.6} \sqrt{\frac{M_2}{28}} \Rightarrow \frac{3}{2} = \frac{1}{2} \sqrt{\frac{M_2}{28}} \Rightarrow \frac{9}{4} = \frac{1}{4} \left(\frac{M_2}{28} \right)$$

Now, $M_2 = 9 \times 28 = 252 \text{ g mol}^{-1}$

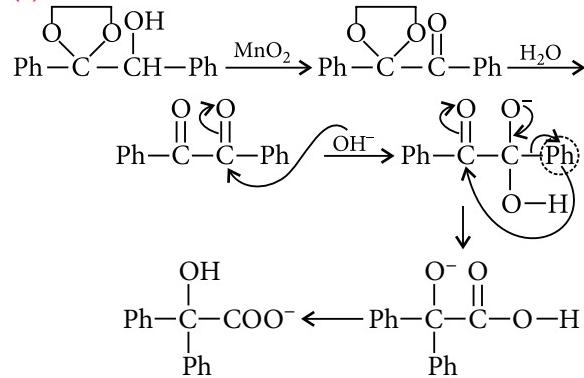
2. (a) Glycerol $\xrightarrow[\text{Excess}]{\text{HCl}}$ Major (X) $\xrightarrow{[\text{O}]}$ (Y)

$\xrightarrow{\text{HCN}}$ HO- $\overset{\text{CH}_2\text{Cl}}{\underset{\text{CH}_2\text{Cl}}{\underset{(\text{Z})}{\text{C}}}}\text{-CN} \xrightarrow{\text{KCN(alc.)}}$ HO- $\overset{\text{CH}_2\text{C}\equiv\text{N}}{\underset{\text{CH}_2\text{C}\equiv\text{N}}{\underset{(\text{A})}{\text{C}}}}\text{-CN}$

$\downarrow \text{H}_2\text{O}/\text{H}^+$

HO- $\overset{\text{CH}_2\text{COOH}}{\underset{\text{CH}_2\text{COOH}}{\underset{(\text{B})}{\text{C}}}}\text{-COOH}$ (Citric acid)

3. (c) :



- 4. (b):** For a compression to occur, p_{ext} must be at least equal to the final pressure of the gas. The final pressure of the gas is,

$$P_f = \frac{P_i V_i}{V_f} = \frac{(3.0 \text{ bar})(2.5 \text{ dm}^3)}{0.5 \text{ dm}^3} = 15 \text{ bar}$$

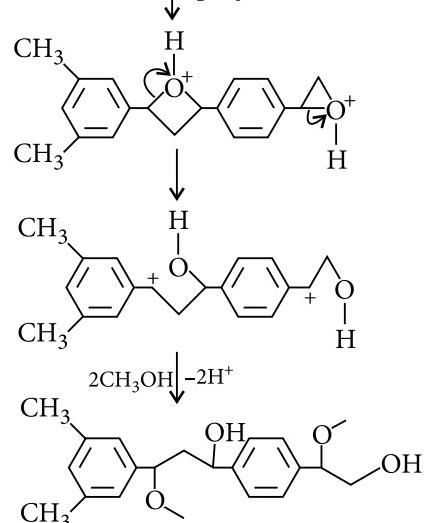
This is the smallest possible value of p_{ext} that can be applied to compress the gas isothermally from 2.5 dm^3 to 0.5 dm^3 . The work done involving the value of p_{ext} is,

$$w = -p_{\text{ext}} \Delta V = -(15 \text{ bar})(0.5 - 2.5) \text{ dm}^3 = 30 \text{ dm}^3 \text{ bar}$$

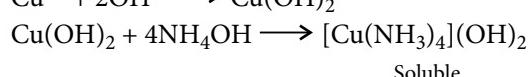
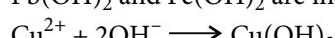
$$= (30 \text{ dm}^3 \text{ bar})(10^{-3} \text{ m}^3 \text{ dm}^{-3})(10^5) \text{ Pa bar}^{-1}$$

$$= 3000 \text{ Pa} \cdot \text{m}^3 = 3000 \text{ J}.$$

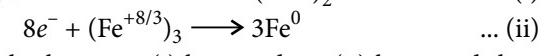
5. (d): 



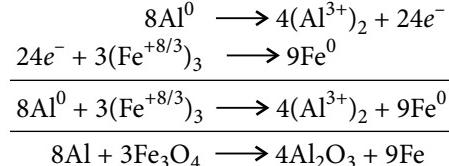
6. (d): $\text{Cu}(\text{OH})_2$ is soluble in NH_4OH , whereas $\text{Pb}(\text{OH})_2$ and $\text{Fe}(\text{OH})_3$ are insoluble.



7. (b): $2\text{Al}^0 \longrightarrow (\text{Al}^{3+})_2 + 6e^-$... (i)

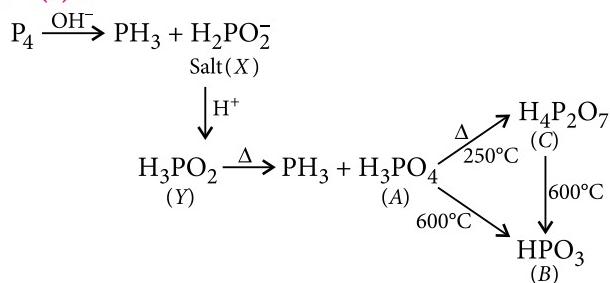


Multiplying eq. (i) by 4 and eq. (ii) by 3, and then adding, we get



Total number of electrons transferred during change = 24.

8. (a):



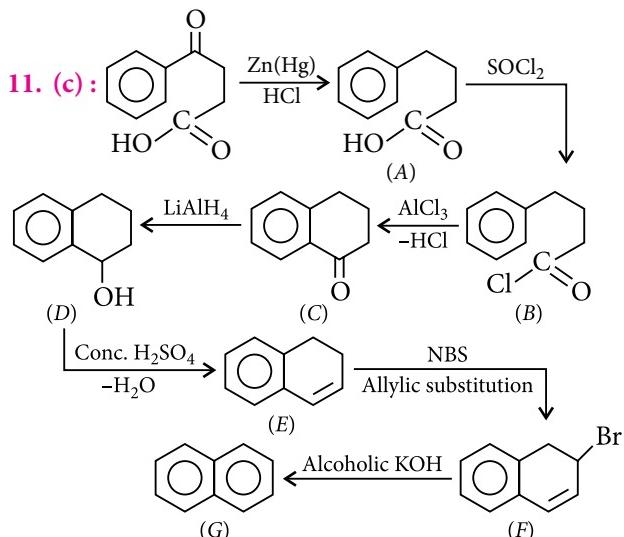
9. (c): For the synthesis of nylon-4, lactam with four carbon atoms is required.

$$10. (\text{d}): \lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}} \quad (\because eV = \frac{1}{2}mv^2)$$

$$= \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times V}}$$

$$= \frac{6.626 \times 10^{-34}}{5.396 \times 10^{-25} [V]^{1/2}} = \frac{1.227 \times 10^{-9}}{[V]^{1/2}} \text{ m}$$

$$= \frac{12.27 \times 10^{-10}}{[V]^{1/2}} \text{ m} = \frac{12.27}{[V]^{1/2}} \text{ Å} = \left[\frac{150}{V} \right]^{1/2} \text{ Å}$$



12. (a)

13. (a): For highest energy transition, $\bar{v} = R_H \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$
Here, for Lyman series $n_1 = 1$ and $n_2 = \infty$

For Balmer series, $n_1 = 2$ and $n_2 = \infty$

$$\frac{\bar{v}_{\text{Lyman}}}{\bar{v}_{\text{Balmer}}} = \frac{1 \times (2)^2}{(1)^2 \times 1} = 4 : 1$$

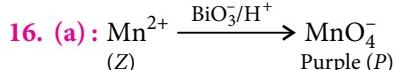
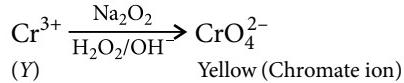
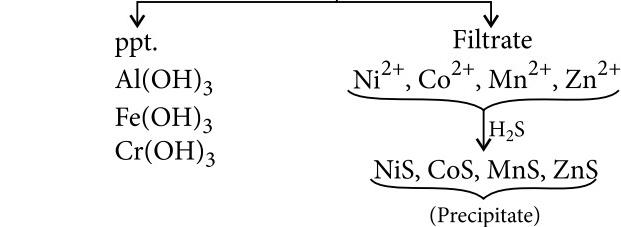
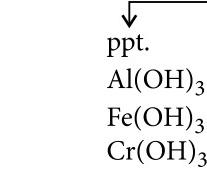
14. (b): For lowest energy transition in Lyman series

$$n_1 = 1, n_2 = 2$$

$$\bar{v} = R_H Z^2 \left[\frac{1}{(1)^2} - \frac{1}{(2)^2} \right] = R_H (2)^2 \left[\frac{1}{1} - \frac{1}{4} \right]$$

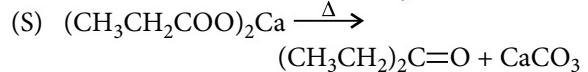
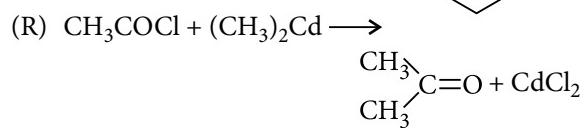
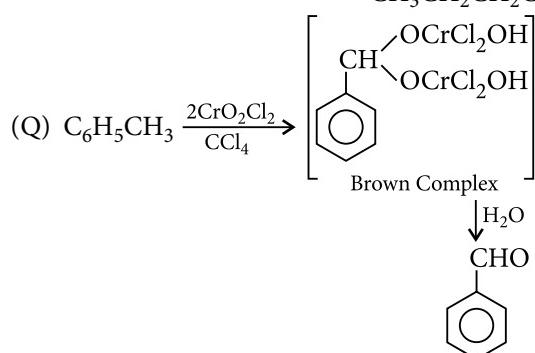
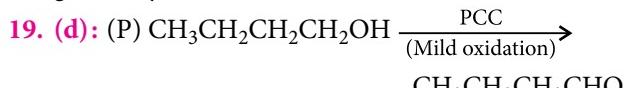
$$= R_H \frac{4 \times 3}{4} = 3R_H$$

15. (b): $\underbrace{\text{Al}^{3+}, \text{Cr}^{3+}, \text{Fe}^{3+}, \text{Zn}^{2+}, \text{Ni}^{2+}, \text{Co}^{2+}, \text{Mn}^{2+}}_{\text{ppt.}}$



17. (a): Shape of XeF_4 is square planar, XeF_6 is distorted octahedral, XeO_3 is trigonal pyramidal and XeO_4 is tetrahedral.

18. (b): Decarboxylation reaction gives a hydrocarbon with one carbon less, Wurtz reaction gives hydrocarbon with even number of carbon atoms, Corey House synthesis can give both symmetrical and unsymmetrical alkanes, dehydrohalogenation gives alkynes.



20. (c): (P) Activation energy for forward reaction
 $= 70 - 40 = 30 \text{ kJ mol}^{-1}$

(Q) Threshold energy = 70 kJ mol^{-1}

(R) Activation energy for backward reaction
 $= 70 - 25 = 45 \text{ kJ mol}^{-1}$

(S) Enthalpy change (ΔH)
 $= 25 - 40 = -15 \text{ kJ mol}^{-1}$





JIPMER

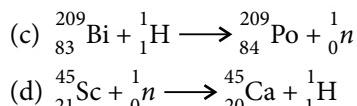
PRACTICE PAPER

Exam on
7th June

1. A current of 2 amp when passed for 5 hours through a molten salt deposits 22.2 g of metal of atomic mass 177. The oxidation state of the metal in the metal salt is
 - (a) + 1
 - (b) + 2
 - (c) + 3
 - (d) + 4
2. Identify the compound 'C' in the following sequence of reactions
$$\text{C}_6\text{H}_6 + \text{CH}_2 = \text{CHCH}_2\text{CH}_2\text{Cl} \xrightarrow{\text{AlCl}_3} A$$
$$A \xrightarrow[\text{(ii) H}_2\text{O}_2, \text{OH}^-]{\text{(i) BH}_3/\text{THF}} B \xrightarrow[\Delta]{\text{HF}} C$$
 - (a)
 - (b)
 - (c)
 - (d)
3. The bond length of HCl bond is 2.29×10^{-10} m. The percentage ionic character of HCl, if measured dipole moment is 6.226×10^{-30} C m, is
 - (a) 8 %
 - (b) 20 %
 - (c) 17 %
 - (d) 50 %
4. The relationship between osmotic pressure at 273 K when 10 g glucose (P_1), 10 g urea (P_2) and 10 g sucrose (P_3) are dissolved in 250 mL of water is
 - (a) $P_1 > P_2 > P_3$
 - (b) $P_3 > P_1 > P_2$
 - (c) $P_2 > P_1 > P_3$
 - (d) $P_2 > P_3 > P_1$
5. Reaction of ethyl formate with excess of CH_3MgI followed by hydrolysis gives
 - (a) *n*-propyl alcohol
 - (b) isopropyl alcohol
 - (c) acetaldehyde
 - (d) acetone.
6. An organic compound containing C, H and N have the percentage 40, 13.33 and 46.67 respectively. Its empirical formula may be
 - (a) $\text{C}_2\text{H}_7\text{N}_2$
 - (b) CH_5N
 - (c) CH_4N
 - (d) $\text{C}_2\text{H}_7\text{N}$
7. Chemically borax is
 - (a) sodium metaborate
 - (b) sodium orthoborate
 - (c) boric anhydride
 - (d) sodium tetraborate decahydrate.
8. Auto-reduction process is used in the extraction of
 - (a) Zn and Hg
 - (b) Cu and Al
 - (c) Fe and Pb
 - (d) Cu and Hg.
9. For a concentrated solution of a weak electrolyte A_xB_y of concentration C , the degree of dissociation α is given as
 - (a) $\alpha = \sqrt{K_{eq}/C(x+y)}$
 - (b) $\alpha = \sqrt{K_{eq}C/(xy)}$
 - (c) $\alpha = (K_{eq}/C^{x+y-1}x^x y^y)^{1/(x+y)}$
 - (d) $\alpha = (K_{eq}/Cxy)$
10. One mole of $\text{N}_2\text{O}_{4(g)}$ at 300 K is kept in a closed container under one atmosphere. It is heated to 600 K when 20% by mass of $\text{N}_2\text{O}_{4(g)}$ decomposes to $\text{NO}_{2(g)}$. The resultant pressure is
 - (a) 2.4 atm
 - (b) 2.0 atm
 - (c) 1.0 atm
 - (d) 1.2 atm
11. By slow distillation of rubber which of the following is obtained?
 - (a) Phenol
 - (b) Aniline
 - (c) Isoprene
 - (d) Chloroprene
12. The major product formed when 2-bromo-butane is treated with alcoholic KOH is
 - (a) 2-Butanol
 - (b) 1-Butene
 - (c) 1-Butanol
 - (d) *trans*-2-butene.
13. Compound formed by electrolysis of a mixture of ethanol and NaCl is
 - (a) ethyl chloride
 - (b) carbon tetrachloride
 - (c) chlorine
 - (d) chloroform.

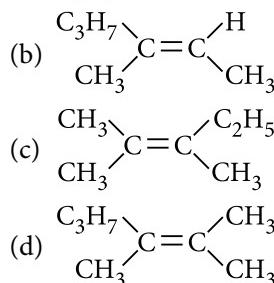
14. Which of the following oxyacids of phosphorus is a reducing agent and monobasic?
 (a) H_3PO_4 (b) H_3PO_3
 (c) H_3PO_2 (d) $\text{H}_4\text{P}_2\text{O}_6$

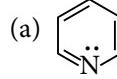
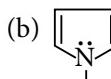
15. Which one of the following transformations is (n, p) type?
 (a) ${}^7_3\text{Li} + {}^1_1\text{H} \longrightarrow {}^7_4\text{Be} + {}^1_0n$
 (b) ${}^{75}_{33}\text{As} + {}^4_2\text{He} \longrightarrow {}^{78}_{35}\text{Br} + {}^1_0n$

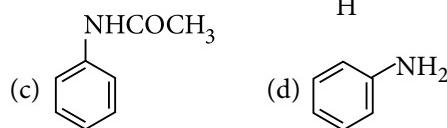


16. Which of the following is an example of absorption?
 (a) Water on silica gel
 (b) Water on calcium chloride
 (c) Hydrogen on finely divided nickel
 (d) Oxygen on metal surface

17. An unsaturated hydrocarbon was treated with ozone and resulting ozonide on hydrolysis gives 2-pentanone and acetaldehyde. What is the structure of alkene?
 (a) $\text{C}_3\text{H}_7 - \text{CH} = \text{CH} - \text{CH}_3$



18. Which one of the following has the most nucleophilic nitrogen?
 (a) 
 (b) 

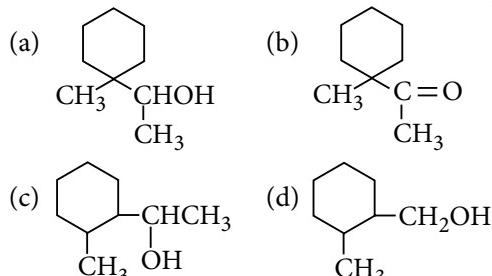
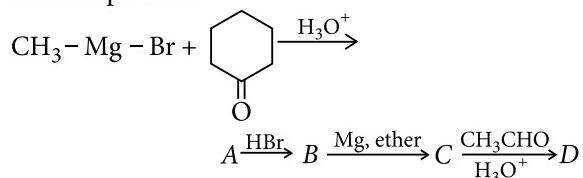


19. The change in entropy for the fusion of 1 mol of ice is [melting point of ice = 273 K, molar enthalpy of fusion for ice = 6.0 kJ mol^{-1}]
 (a) $11.73 \text{ J K}^{-1} \text{ mol}^{-1}$ (b) $18.85 \text{ J K}^{-1} \text{ mol}^{-1}$
 (c) $21.97 \text{ J K}^{-1} \text{ mol}^{-1}$ (d) $24.47 \text{ J K}^{-1} \text{ mol}^{-1}$

20. Paracetamol is a/an
 (a) analgesic (b) antipyretic
 (c) both (a) and (b) (d) antimarial.

21. In a reaction,
 $4\text{P} + 3\text{KOH} + 3\text{H}_2\text{O} \rightarrow 3\text{KH}_2\text{PO}_2 + \text{PH}_3$, Phosphorus is
 (a) reduced
 (b) oxidized
 (c) neither reduced nor oxidized
 (d) both reduced and oxidized.

22. In the following sequence of the reactions, identify the final product.



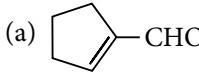
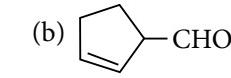
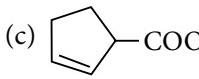
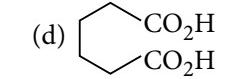
23. The correct structure of $\text{Fe}(\text{CO})_5$ is (at. no. of Fe = 26)
 (a) trigonal bipyramidal
 (b) octahedral
 (c) tetrahedral
 (d) square pyramidal.

24. A 100% pure sample of a divalent metal carbonate weighing 2 g on complete thermal decomposition releases 448 cc of carbon dioxide at STP. The equivalent mass of the metal is

- (a) 40 (b) 20
 (c) 28 (d) 12

25. Uncertainty in position of an electron (mass = $9.1 \times 10^{-28} \text{ g}$) moving with a velocity of $3 \times 10^4 \text{ cm/s}$ accurate upto 0.001% will be (use $h/4\pi$ in uncertainty expression where $h = 6.626 \times 10^{-27} \text{ erg s}$)
 (a) 5.76 cm (b) 7.68 cm
 (c) 1.93 cm (d) 3.84 cm

26. The rate law of a chemical reaction,
 $2\text{NO}_{(g)} + \text{O}_{2(g)} \rightarrow 2\text{NO}_{2(g)}$ is given as rate = $k [\text{NO}]^2[\text{O}_2]$. If the volume of reaction vessel is increased four times its initial volume, then rate of reaction

- (a) becomes $\frac{1}{64}$ th of initial rate
 (b) becomes $\frac{1}{4}$ th of initial rate
 (c) becomes $\frac{1}{16}$ th of initial rate
 (d) becomes 4 times of initial rate.
27. The equilibrium constant of the following redox reaction at 298 K is 1×10^8 :
- $$2\text{Fe}^{3+}_{(aq)} + 2\text{I}^-_{(aq)} \rightleftharpoons 2\text{Fe}^{2+}_{(aq)} + \text{I}_2_{(s)}$$
- If the standard reduction potential of iodine becoming iodide is +0.54 V, what is the standard reduction potential of $\text{Fe}^{3+}/\text{Fe}^{2+}$?
- (a) + 1.006 V (b) - 1.006 V
 (c) + 0.77 V (d) - 0.77 V
28. Total volume of atoms present in a face centred cubic unit cell of a metal is (r is atomic radius)
- (a) $\frac{16}{3}\pi r^3$ (b) $\frac{20}{3}\pi r^3$
 (c) $\frac{24}{3}\pi r^3$ (d) $\frac{12}{3}\pi r^3$
29. In the 3rd period, the first ionisation potential is of the order
- (a) Na > Mg > Al > Si > P
 (b) Mg > Na > Si > P > Al
 (c) Na < Mg < Al < Si < P
 (d) Na < Al < Mg < Si < P
30. The ionic radii of Group-12 metals Zn, Cd and Hg are smaller than those of Group-2 metals because Zn, Cd and Hg have
- (a) 10 d -electrons which shield the nuclear charge poorly
 (b) 10 d -electrons which shield the nuclear charge strongly
 (c) 10 d -electrons which have a large radius ratio
 (d) 10 d -electrons which have a large exchange energy.
31. The enzyme which can catalyse the conversion of glucose to ethanol is
- (a) zymase (b) invertase
 (c) maltase (d) diastase.
32. In the reaction : $A_{2(g)} + 3B_{2(g)} \rightarrow 2AB_{3(g)}$, the standard entropies (in $\text{J K}^{-1} \text{ mol}^{-1}$) of $A_{2(g)}$, $B_{2(g)}$ and $AB_{3(g)}$ are respectively 190, 130 and 195 and the standard enthalpy change for the reaction is -95 kJ mol^{-1} . The temperature (in K) at which the reaction attains equilibrium is
- (a) 500 (b) 400
 (c) 300 (d) 600
33. Which of the following compounds does not leave residue on heating?
- (a) Lead nitrate
 (b) Ammonium nitrate
 (c) Silver nitrate
 (d) Sodium nitrate
34. Cyclohexene on ozonolysis followed by reaction with zinc dust and water gives compound E. Compound E on further treatment with aqueous KOH yields compound F. Compound F is
- (a)  (b) 
 (c)  (d) 
35. For the redox reaction,
- $$\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \text{H}^+ \longrightarrow \text{Mn}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$$
- the correct coefficient of the reactants for the balanced reaction are
- | | | |
|------------------|-----------------------------|--------------|
| MnO_4^- | $\text{C}_2\text{O}_4^{2-}$ | H^+ |
| (a) 2 | 5 | 16 |
| (b) 16 | 3 | 12 |
| (c) 15 | 16 | 12 |
| (d) 2 | 16 | 5 |
36. As a result of dissolution of NaCl in water, the entropy
- (a) increases
 (b) decreases
 (c) remains unchanged
 (d) becomes zero.
37. Ammonia is a Lewis base and it forms complexes with many cations. Which one of the following cations does not form a complex with ammonia?
- (a) Ag^+ (b) Cu^{2+}
 (c) Cd^{2+} (d) Pb^{2+}
38. Haemoglobin contains 0.334% of iron by weight. The molecular weight of haemoglobin is approximately 67200. The number of iron atoms (Atomic weight of Fe is 56) present in one molecule of haemoglobin is
- (a) 1 (b) 2
 (c) 4 (d) 6
39. Arrange the following compounds in increasing order of their boiling points.

54. How many atoms are there in 4.25 g of NH₃?

- (a) 6×10^{23} (b) 1.5×10^{23}
 (c) 3.4×10^{23} (d) 1×10^{23}

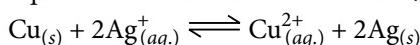
55. Complete hydrolysis of cellulose gives

- (a) D-fructose (b) D-ribose
 (c) D-glucose (d) L-glucose.

56. 2-Phenylethanol may be prepared by the reaction of phenyl magnesium bromide with

- (a) HCHO (b) CH₃CHO
 (c) CH₃COCH₃ (d)

57. The equilibrium constant of the reaction,



$E^\circ = 0.46 \text{ V}$ at 298 K is

- (a) 2.0×10^{10} (b) 4.0×10^{10}
 (c) 4.0×10^{15} (d) 2.4×10^{10}

58. The highest boiling point is expected for

- (a) iso-octane
 (b) n-octane
 (c) 2,2,3,3-tetramethylbutane
 (d) n-butane.

59. Hyperconjugation is most useful for stabilizing which of the following carbocations?

- (a) neo-Pentyl (b) tert-Butyl
 (c) iso-Propyl (d) Methyl

60. Osmotic pressure of urea solution at 10°C is 500 mm. The solution is diluted with temperature raised to 25°C till its osmotic pressure becomes 131.6 mm. The solution is diluted

- (a) 3 times (b) 3.5 times
 (c) 4 times (d) 3.8 times.

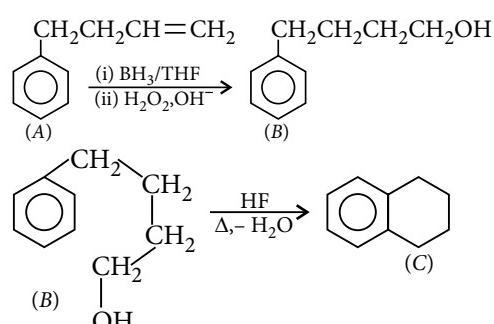
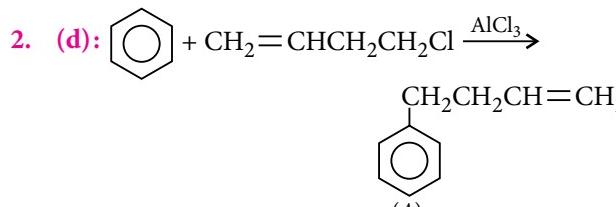
SOLUTIONS

1. (c) : Eq.wt. = $\frac{W}{Q} \times 96500$ and $Q = I \times t$

$$\therefore E = \frac{22.2 \times 96500}{2 \times 5 \times 3600} = 59.5$$

$$\therefore \text{Equivalent mass} = \frac{\text{Atomic mass}}{\text{Oxidation state}}$$

$$59.5 = \frac{177}{n} \quad \therefore n = 2.97 \approx 3$$



3. (c) : $\mu_{\text{cal.}} = q \times d = 1.6 \times 10^{-19} \times 2.29 \times 10^{-10}$
 $= 3.664 \times 10^{-29} \text{ C m}$

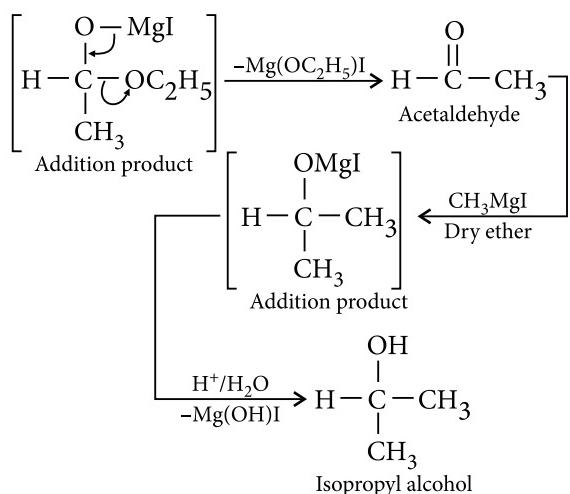
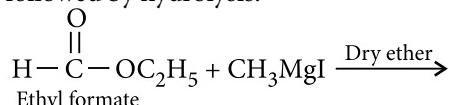
$$\% \text{ ionic character} = \frac{\mu_{\text{exp}}}{\mu_{\text{cal}}} \times 100$$

$$= \frac{6.226 \times 10^{-30}}{3.664 \times 10^{-29}} \times 100$$

$$= 17 \%$$

4. (c) : $P = \frac{w}{mV} RT$; since w , V and T are same, thus $P \propto (1/m)$.

5. (b) : Secondary alcohol is obtained by reaction of ethyl formate with an excess of Grignard reagent followed by hydrolysis.

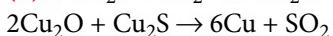
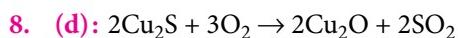


6. (c) :

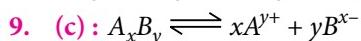
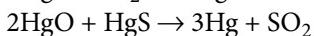
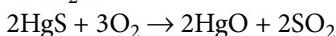
Element	%	Atomic mass	Relative no. of atoms	Simplest ratio
C	40	12	40/12 = 3.33	3.33/3.33 = 1
H	13.33	1	13.33/1 = 13.33	13.33/3.33 = 4
N	46.67	14	46.67/14 = 3.33	3.33/3.33 = 1

Empirical formula of the compound = CH_4N

7. (d) : Chemically, borax is sodium tetraborate or sodium tetraborate decahydrate i.e. $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$.



Auto-reduction of Cu_2O takes place due to presence of Cu_2S .



where α = degree of dissociation.

$$\therefore K_{eq} = \frac{(Cx\alpha)^x (Cy\alpha)^y}{C(1-\alpha)}$$

For concentrated solution of weak electrolyte, α is very small. Therefore, $(1 - \alpha) \approx 1$.

$$\therefore \alpha = \left(\frac{K_{eq}}{C^{x+y-1} x^x y^y} \right)^{\frac{1}{x+y}}$$



Initial moles	1	0
At equilibrium	1 - 0.2	2×0.2
	= 0.8	= 0.4

Total number of moles = $0.8 + 0.4 = 1.2$

$$\text{Now applying, } \frac{P_1}{n_1 T_1} = \frac{P_2}{n_2 T_2}$$

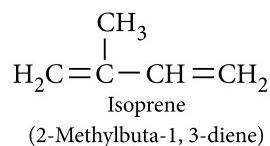
$$P_1 = 1 \text{ atm}, P_2 = ?$$

$$n_1 = 1 \text{ mole}, n_2 = 1.2 \text{ mole}$$

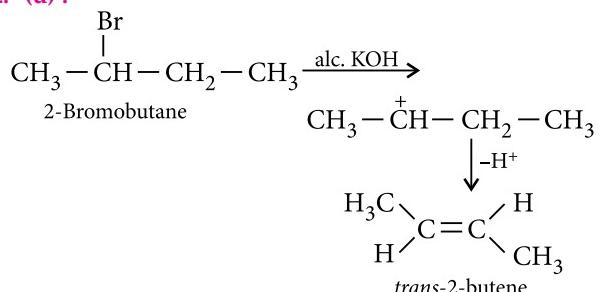
$$T_1 = 300 \text{ K}, T_2 = 600 \text{ K}$$

$$P_2 = \frac{1 \times 1.2 \times 600}{1 \times 300} = 2.4 \text{ atm}$$

11. (c) : Natural rubber is a hydrocarbon polymer $(\text{C}_5\text{H}_8)_n$. On destructive distillation, it gives mainly isoprene.

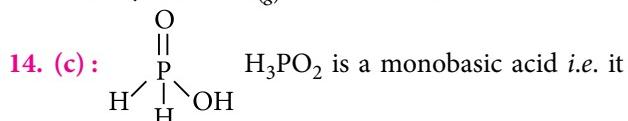


12. (d) :



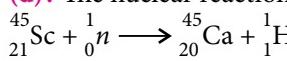
13. (c) : Ethanol is a covalent compound hence, does not undergo electrolysis.

Sodium chloride being an ionic compound undergoes electrolysis and $\text{Cl}_{2(g)}$ will be liberated at anode.



has one OH group and two P-H bonds which are responsible for its reducing character.

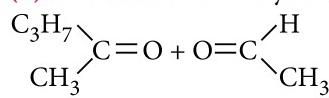
14. (c) : The nuclear reaction,



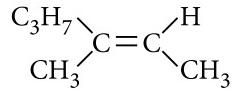
represented as, ${}_{21}^{45}\text{Sc}(n, p){}_{20}^{45}\text{Ca}$.

16. (b) : Anhydrous calcium chloride acts as a dehydrating agent, it removes water by the process of absorption.

17. (b) : Products of ozonolysis are



Hence, the structure of an alkene is



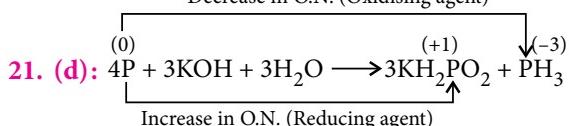
18. (a) : In option (b), lone pair of electrons on N is a part of aromaticity and in option (c), NH- group is adjacent to electron withdrawing group and in option (d), lone pair is a part of resonance. So, in pyridine N is most nucleophilic.

19. (c) : $\Delta H_{\text{fusion}} = 6.0 \text{ kJ mol}^{-1} = 6.0 \times 10^3 \text{ J mol}^{-1}$

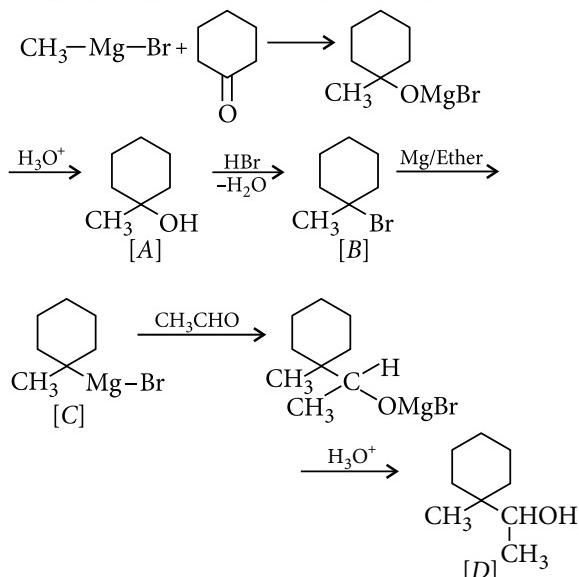
$$\Delta S_{\text{fusion}} = \frac{\Delta H_{\text{fusion}}}{T_{\text{m.p.}}} = \frac{6.0 \times 10^3 \text{ J mol}^{-1}}{273 \text{ K}} \\ = 21.978 \text{ J K}^{-1} \text{ mol}^{-1}$$

20. (c) : Paracetamol (4-Aacetamidophenol) helps to reduce fever as well as relieves pain.

Decrease in O.N. (Oxidising agent)



22. (a) : Alkyl halides are starting materials for the preparation of Grignard reagents which are used for preparing number of organic compounds.



23. (a) : ${}_{26}\text{Fe}$: [Ar] $3d^6 4s^2$

Ground state :

3d	4s	4p						

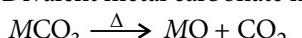
CO being strong field ligand, causes pairing of electrons.

Excited state :

3d	4s	4p						

dsp^3
(Trigonal bipyramidal)

24. (b) : Divalent metal carbonate means MCO_3 .



$$1 \text{ mol} \quad 22400 \text{ cc}$$

$$2 \text{ g} \quad 448 \text{ cc}$$

\therefore 448 cc of CO_2 is evolved from 2 g of MCO_3

\therefore 22400 cc of CO_2 will be evolved from

$$\frac{2}{448} \times 22400 \text{ g} = 100 \text{ g of } MCO_3$$

i.e. 100 g is the molecular wt. of the carbonate.

Then mol. wt. of metal = $100 - (12 + 3 \times 16)$

(wt. of carbonate, CO_3^{2-})

= 40 g

$$\text{Equivalent wt.} = \frac{\text{Molecular weight}}{\text{Valency}} = \frac{40}{2} = 20$$

25. (c) : Mass of an electron (m) = 9.1×10^{-28} g;

Velocity of electron (v) = 3×10^4 cm/s;

$$\text{Accuracy} = 0.001\% = \frac{0.001}{100}$$

Planck's constant (h) = 6.626×10^{-27} erg second.

We know that actual velocity of the electron

$$(\Delta v) = 3 \times 10^4 \times \frac{0.001}{100} = 0.3 \text{ cm/s}$$

Therefore, uncertainty in the position of the electron

$$(\Delta x) = \frac{h}{4\pi m \Delta v} = \frac{6.626 \times 10^{-27}}{4\pi \times (9.1 \times 10^{-28}) \times 0.3} = 1.93 \text{ cm}$$

26. (a) : If volume is increased four times, the concentration of each reactant will reduce to one fourth of initial value.

$$\text{Given, Rate } (r_1) = k [NO]^2 [O_2]$$

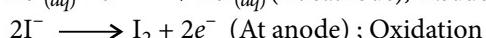
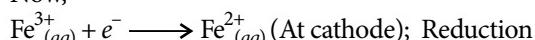
On increasing volume,

$$\begin{aligned} \text{Rate } (r_2) &= k \left[\frac{1}{4} NO \right]^2 \left[\frac{1}{4} O_2 \right] \\ &= \frac{1}{16} \times \frac{1}{4} k [NO]^2 [O_2] = \frac{1}{64} r_1 \end{aligned}$$

$$27. (c) : E^\circ_{\text{cell}} = \frac{2.303RT}{nF} \log K_{eq}$$

$$= \frac{2.303 \times 8.314 \times 298}{2 \times 96500} \times \log [1 \times 10^8] = 0.236 \text{ V}$$

Now,



and we know that

$$E^\circ_{\text{cell}} = E^\circ_{\text{cathode}} - E^\circ_{\text{anode}}$$

$$\text{given, } E^\circ_{\text{anode}} = 0.54 \text{ V}$$

$$\therefore E^\circ_{\text{cathode}} = E^\circ_{\text{cell}} + E^\circ_{\text{anode}} = 0.236 + 0.54 = +0.776 \text{ V}$$

28. (a) : In fcc, no. of spheres in the unit cell

$$= 8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$$

$$\text{Volume of 4 spheres} = 4 \times \frac{4}{3} \pi r^3$$

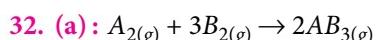
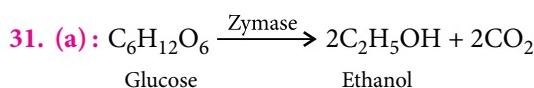
$$= \frac{16}{3} \pi r^3$$

29. (d): Ionisation potential increases across a period with increasing atomic number. But Mg ($1s^2 2s^2 2p^6 3s^2$) has higher ionisation enthalpy than Al ($1s^2 2s^2 2p^6 3s^2 3p^1$) due to stable fully filled orbitals of magnesium.

Thus, the correct order is :



30. (a): Zn, Cd and Hg have smaller ionic radii than group-2 elements because former involve 10 d -electrons which have poor shielding effect so that electrons are more strongly attracted towards nucleus.



$$S^\circ_{A_2} = 190 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$S^\circ_{B_2} = 130 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$S^\circ_{AB_3} = 195 \text{ J K}^{-1} \text{ mol}^{-1}$$

ΔS° for the reaction,

$$\begin{aligned} \Delta S^\circ &= (2 \times S^\circ_{AB_3}) - (S^\circ_{A_2} + 3 \times S^\circ_{B_2}) \\ &= (2 \times 195) - (190 + 3 \times 130) \\ &= 390 - 580 = -190 \text{ J K}^{-1} \text{ mol}^{-1} \end{aligned}$$

$$\Delta H^\circ = -95 \text{ kJ mol}^{-1}$$

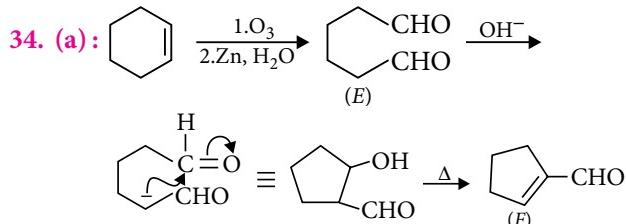
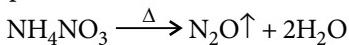
As we know, $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

At equilibrium, $\Delta G^\circ = 0$

$$\text{i.e. } \Delta H^\circ = T\Delta S^\circ$$

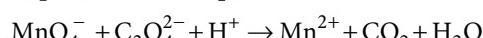
$$T = \frac{\Delta H^\circ}{\Delta S^\circ} = \frac{-95 \times 1000}{-190} = 500 \text{ K}$$

33. (b): Ammonium nitrate on heating gives gaseous products. Hence, leaves no residue.



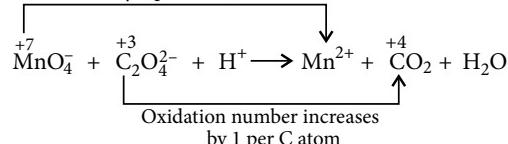
35. (a): Let us balance the given equation by oxidation number method.

Step (i) : Skeletal equation



Step (ii) : Identify change in oxidation number

Oxidation number decreases
by 5 per Mn atom

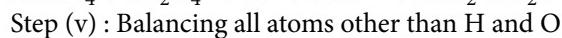
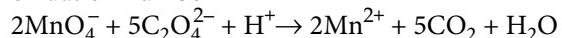


Step (iii) : Total increase in oxidation number

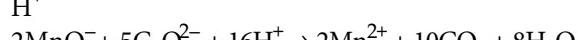
$$= 2 \times 1 = 2$$

Total decrease in oxidation number = $5 \times 1 = 5$

Step (iv) : Equalising total increase and decrease in oxidation number



Step (vi) : Balancing H and O by adding H_2O and H^+



The ions that were held together in crystalline solid are now moving in all possible directions. Thus entropy increases.

37. (d): Pb^{2+} is a *p*-block element and does not form complex ion.

38. (c): $\because 100 \text{ g of haemoglobin contains} = 0.334 \text{ g Fe}$
 $\therefore 67200 \text{ g of haemoglobin contains}$

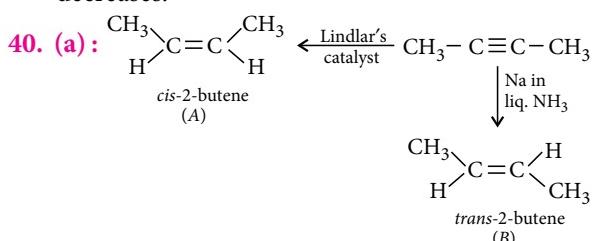
$$\begin{aligned} &= \frac{0.334 \times 67200}{100} \text{ g Fe} \\ &= 224.45 \text{ g Fe} \end{aligned}$$

Now,

$$\therefore 56 \text{ g iron} = 1 \text{ atom of Fe}$$

$$\therefore 224.45 \text{ g iron} = \frac{1 \times 224.45}{56} = 4 \text{ atoms}$$

39. (c): Boiling point increases as the branching decreases.



41. (c): Smelting is the process of extraction of a metal by reduction of its oxide with carbon (in the form of coke, charcoal or carbon monoxide).

42. (b): Generally, the first ionization energy increases as we go across a period. Hence, the maximum peaks in curve are occupied by rare gases.

43. (a): Smaller cation (Li^+) is stabilised by smaller anion (F^-). Thus LiF has high lattice energy and is the most stable compound.

44. (d): Ge^{4+} is more stable than Ge^{2+} as a result of which Ge^{2+} has a tendency to be oxidised to Ge^{4+} so Ge^{2+} compounds act as powerful reducing agents. But Pb^{2+} is more stable than Pb^{4+} because of pronounced inert pair effect as a result of which Pb^{4+} has a tendency to get reduced to Pb^{2+} so Pb^{4+} compounds act as strong oxidising agents (i.e. oxidants).

45. (c) : $\ln \frac{k_2}{k_1} = \frac{E_a}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$

or, $\ln \frac{k_2}{k_1} = \frac{600 R}{R} \left(\frac{1}{300} - \frac{1}{600} \right)$

or, $\ln \frac{k_2}{k_1} = \frac{600 R}{R} \left(\frac{2-1}{600} \right) = 1$

or, $\ln \frac{k_2}{k_1} = \ln e$

$$\frac{k_2}{k_1} = e$$

46. (c) : ccp lattice consists of four atoms per unit cell. Thus, number of copper atoms per unit cell = 4 (ccp)

Number of silver atoms per unit cell

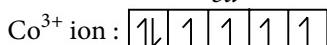
$$= \frac{1}{4} \times 12 = 3 \text{ (edge centre)}$$

Number of gold atoms per unit cell = 1
(body centre)

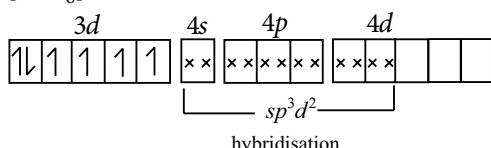
Thus, formula of the compound = $\text{Cu}_4\text{Ag}_3\text{Au}$

47. (a) : Electronic configurations of

$3d^6$

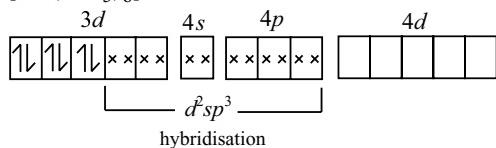
Co^{3+} ion : 

$[\text{CoF}_6]^{3-}$ ion :

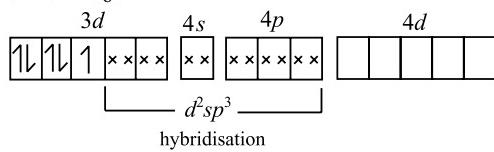


F^- , being a weak field ligand cannot cause forcible pairing of electrons within d -subshell and forms outer orbital octahedral complex.

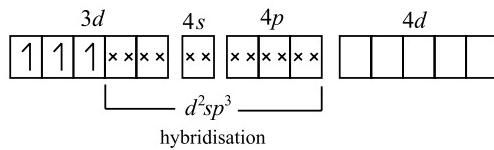
$[\text{Co}(\text{NH}_3)_6]^{3+}$ ion :



$[\text{Fe}(\text{CN})_6]^{3-}$ ion :



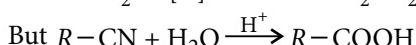
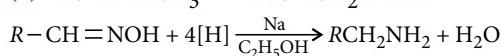
$[\text{Cr}(\text{NH}_3)_6]^{3+}$ ion :



NH_3 and CN^- are strong field ligands, so they form inner orbital octahedral complexes.

48. (d)

49. (c) : $R-\text{X} + \text{NH}_3 \longrightarrow R-\text{NH}_2 + \text{HX}$



50. (b) : Average life = $1.44 \times$ half life ($t_{1/2}$)

$$= 1.44 \times 40$$

$$= 57.6 \text{ days}$$

51. (d) : Lyman series, $n_1 = 1$

For third line of Lyman series, $n_2 = 4$

For hydrogen, $Z = 1$

$$v_H = \frac{c}{\lambda} = c \cdot R_H Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$= c \cdot R_H (1)^2 \left(\frac{1}{1} - \frac{1}{(4)^2} \right) = \frac{15}{16} R_H \cdot c$$

For lithium, $Z = 3$

For first line of Balmer series, $n_1 = 2$, $n_2 = 3$

$$v_{\text{Li}^{2+}} = c \cdot R_H (3)^2 \left(\frac{1}{(2)^2} - \frac{1}{(3)^2} \right) = c \cdot R_H \times 9 \times \frac{5}{36}$$

$$= \frac{5}{4} c \cdot R_H$$

$$\frac{v_H}{v_{\text{Li}^{2+}}} = \frac{(15/16) c R_H}{(5/4) c R_H} = \frac{15}{16} \times \frac{4}{5} = \frac{3}{4}$$

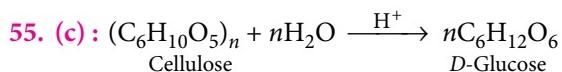
52. (b) : PVC is a thermoplastic polymer and its plasticity can be increased by addition of plasticizer.

53. (c) : Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria are said to be broad spectrum antibiotics.

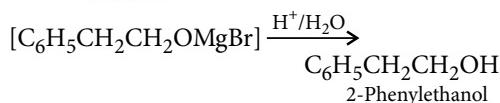
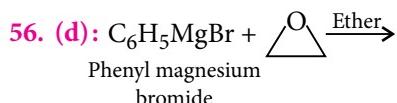
54. (a) : The no. of molecules = $\frac{\text{Given mass}}{\text{Molar mass}} \times N_A$
 $= \frac{4.25}{17} \times 6.022 \times 10^{23}$
 $= 1.5055 \times 10^{23}$

One molecule of NH_3 has 4 atoms.

Hence no. of atoms = $1.5055 \times 10^{23} \times 4$
 $= 6.022 \times 10^{23}$



Cellulose is a straight chain polysaccharide composed of *D*-glucose units which are joined by β -glycosidic linkages. Hence, cellulose on hydrolysis produces only *D*-glucose units.



57. (c) : $K = \text{antilog} \left[\frac{nE^\circ}{0.059} \right] = \text{antilog} \left[\frac{2 \times 0.46}{0.059} \right]$
 $= \text{antilog } 15.593$
 $= 3.9 \times 10^{15} \approx 4 \times 10^{15}$

58. (b) : Boiling point of alkanes increases with increase in molecular mass. For a particular compound, straight chain isomer has higher boiling point than branched chain isomer due to larger surface area.

59. (b) : Stability order of different alkyl carbocations, on the basis of hyperconjugation is $3^\circ > 2^\circ > 1^\circ >$ methyl. In *tert*-butyl cation, the C-atom bearing the positive charge is attached to three methyl groups, thus, it will give nine hyperconjugative structures, thus causing maximum stability.

60. (c) : $\pi = \frac{n}{V} RT$

Before dilution, $\frac{500}{760} = \frac{n}{V_1} \times 0.0821 \times 283$... (i)

After dilution, $\frac{131.6}{760} = \frac{n}{V_2} \times 0.0821 \times 298$... (ii)

Dividing (i) by (ii), $\frac{V_2}{V_1} = \frac{500}{131.6} \times \frac{298}{283} = 4$

$\therefore V_2 = 4V_1$





MCQ's

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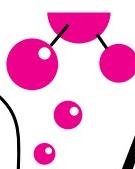
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ADVANCED CHEMISTRY BLOC

(CONCEPT OF FREE ENERGY)

Mukul C. Ray, Odisha

Free Energy and Spontaneity

To judge whether the process is spontaneous or not, the entropy change of the system as well as surroundings is taken together. Both taken together if become positive, the process is said to be spontaneous. Is there another thermodynamic function which can predict the spontaneity of the process by looking into the system only?

Consider a system that is in thermal equilibrium with its surroundings so that $T_{\text{sys}} = T_{\text{surr}} = T$. The condition for the spontaneous change in terms of entropy for an infinitesimal process is

$$dS_{\text{sys}} + dS_{\text{surr}} > 0$$

And, $dS_{\text{surr}} = \frac{dq_{\text{surr}}}{T} = \frac{-dq_{\text{sys}}}{T}$

Because, the heat gained by the surroundings is equal to the heat lost by the system. So,

$$dS_{\text{sys}} - \frac{dq_{\text{sys}}}{T} > 0$$

$$TdS_{\text{sys}} > dq_{\text{sys}}$$

Now, if heat is transferred to the system at constant pressure and there is no non-PV work, it can be written as $(dq)_p = dH$

Eliminating the subscript 'system' completely,

$$TdS > dH \text{ (At constant } P, \text{ no non-PV work)}$$

$$\text{or, } dH - TdS < 0 \text{ (At constant } P, \text{ no non-PV work)}$$

Here, both dH and dS are the properties of the system. Thus the surroundings have been eliminated successfully from the equation of criterion of spontaneity.

Together these two thermodynamic functions thus define a new one called Gibbs free energy and is written as

$$G = H - TS \text{ and, } dG = dH - TdS$$

A change in system at constant temperature and pressure is spontaneous if $(dG)_{T, P} < 0$. That is a change under these conditions is spontaneous, if it corresponds to decrease in Gibbs free energy function.

At constant volume and temperature conditions when, there is no non-PV work, the criterion of spontaneity becomes $(dA)_{T, V} < 0$, where 'A' is called as the Helmholtz function.

Free Energy Change and Maximum Work

In a general change,

$$dH = dU + d(PV)$$

$$dH = dq + dw + d(PV)$$

$$\text{or, } dG = dq + dw + d(PV) - TdS$$

When the change is reversible, $dq = TdS$ and $dw = dw_{\text{max}}$. Thus the change in Gibbs free energy can be written as

$$dG = TdS + dw_{\text{max}} + d(PV) - TdS$$

$$\text{or, } dG = dw_{\text{max}} + d(PV)$$

The work consists of $P-V$ work, which for a reversible infinitesimal change is $-PdV$, and possibly some other kind of work like electrical work. Let this non-PV work be called as $dw_{e, \text{max}}$. Thus, there are two types of work now the equation becomes

$$dG = -PdV + dw_{e, \text{max}} + PdV + VdP$$

$$\text{or, } dG = dw_{e, \text{max}} + VdP$$

If the change occurs at constant pressure as well as at constant temperature,

$$(dG)_{T, P} = dw_{e, \text{max}}$$

This means that the change in Gibbs free energy of a function for a process is equal to maximum non PV work done on the system.

$$w_{e, \text{max}} = -\Delta G(T, P \text{ constant})$$

This expression is used for electrical work obtained from fuel cell and other electrochemical cells.

Maximum Work and Enthalpy Change

Some more outcomes of this equation are :

$$w_{\text{max}} = -\Delta G = -\Delta H + T\Delta S$$

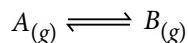
If the sign of $T\Delta S$ is negative, it means the process is accompanied by decrease in entropy of the system, the maximum work that can be done is less than the value of $-\Delta H$. Suppose the enthalpy change for a process is

-7 units then $-\Delta H$ is +7 units and if the sign of $T\Delta S$ is negative, work obtained will be less than +7 units. This is because some of the heat lost by the system must escape to the surroundings to raise its entropy to overpower the loss in entropy of the system and to make overall entropy change positive.

On the other hand, if the change occurs with an increase in entropy of the system, maximum work obtainable can be greater than the value of $-\Delta H$. It appears as a contradiction. But this happens as heat flows in from the surroundings when work is done by the system. Entropy of the surroundings decreases a bit but overall entropy change for the process is positive.

Free Energy and Equilibrium

When the components of a given chemical reaction are mixed, they will proceed rapidly or slowly, depending on the kinetics of the process towards equilibrium position. To understand the relationship between equilibrium and free energy, consider the following hypothetical reaction:



If reaction is started with 'A', then the free energy of component 'A' decreases and that of 'B' increases till it is lower than the free energy of 'A'. Finally, free energy of both 'A' and 'B' becomes equal and equilibrium is said to have reached. The system has now reached minimum free energy. There is no longer any driving force to change 'A' to 'B' or 'B' to 'A'



Free energy of A
↓
Free energy of B

As the reaction proceeds free energy of reactant decreases and that of product increases.



Free energy of A

Free energy of B

At equilibrium both the components have identical free energy.

The plot of decrease in free energy against fraction of 'A' reacted is shown in figure-1.

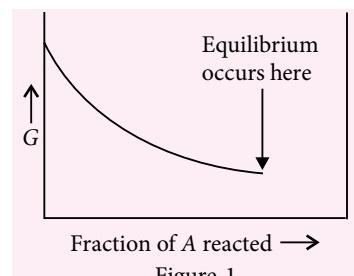


Figure-1

The change in free energy to reach equilibrium beginning with 'B' is shown in figure-2.

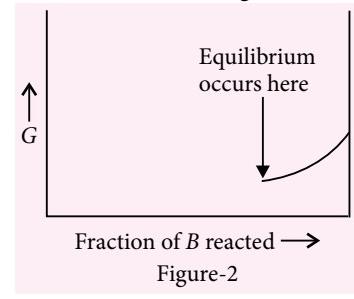


Figure-2

The overall process is given in figure-3. Each point on the curve in figure-3 corresponds to the total free energy for a given combination of 'A' and 'B'.

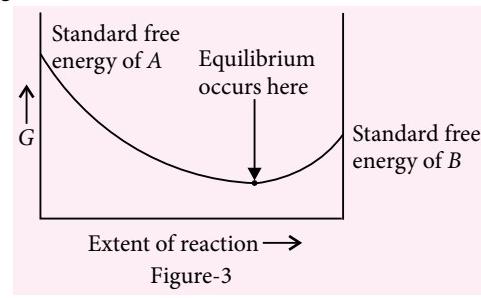


Figure-3

Coming to the famous equation:

$$\Delta G = \Delta G^\circ + RT \ln Q$$

where Q is the reaction quotient. At equilibrium, ΔG becomes zero and Q becomes K .

Thus, $\Delta G^\circ = -RT \ln K$

So naturally when K is one, ΔG° becomes zero. The difference in the standard free energies of 'A' and 'B' (figure-3) give the value of ΔG° .

What is 'Free' about Free Energy

For a process to be spontaneous, ΔS_{total} should be positive. It does not have to be massively positive, just a little bit higher. Heat escapes to the surroundings to raise the entropy of the surroundings so that the process becomes feasible. But, if the surroundings is satisfied with a little heat then why release a large amount of heat to the surroundings? The rest energy is 'free' to do work like push piston, spin shafts, raise weights etc.



PRACTICE PAPER

AIIMS

Exam on : 1st June



- 1.** Cyanohydrin of which of the following forms lactic acid?
 (a) HCHO (b) CH₃CHO
 (c) CH₃CH₂CHO (d) CH₃COCH₃

2. One gram mole of a gas at N.T.P. occupies 22.4 litres. This fact was derived from
 (a) law of gaseous volumes
 (b) Dalton's atomic theory
 (c) Avogadro's hypothesis
 (d) law of constant proportions

3. It costs ₹ 10 to electrodeposit 1 g of Mg from a solution of MgSO₄. The cost of electrodepositing 1 g of Al from Al₂(SO₄)₃ solution at the same temperature is (atomic weight of Mg = 24, Al = 27)
 (a) ₹ 10 (b) ₹ 6.66
 (c) ₹ 13.33 (d) ₹ 8.4

4. Which of the following alkenes will give same product by any method out of hydration, hydroboration-oxidation and oxymercuration-demercuration?
 (a) CH₃CH=CH₂ (b) CH₃CH=CHCH₃
 (c) CH₃CHCH=CH₂ (d) 

5. To liquefy gaseous substances whose critical temperatures are below room temperature requires
 (a) high pressure and lowering of temperature (below T_c)
 (b) low pressure and raising of temperature (above T_c)
 (c) high pressure and raising of temperature (above T_c)
 (d) low pressure and lowering of temperature (below T_c).

6. The most common minerals of phosphorus are
 (a) hydroxyapatite and fluorapatite
 (b) colemanite and fluorapatite
 (c) borax and fluorapatite
 (d) hydroxyapatite and colemanite.

7. Numbers of formula units in unit cells of MgO (rock salt), ZnS (zinc blende) and Pt (fcc) respectively are
 (a) 4, 3, 2 (b) 4, 3, 4
 (c) 4, 4, 4 (d) 4, 3, 1

8. Among the following compounds, the decreasing order of reactivity towards electrophilic substitution is


I

II

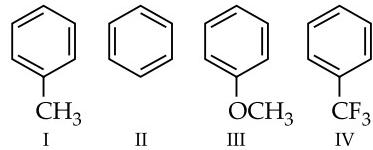
III

IV

(a) III > I > II > IV (b) IV > I > II > III
 (c) I > II > III > IV (d) II > I > III > IV

9. Which among the following has the largest dipole moment?
 (a) HI (b) H₂O
 (c) NH₃ (d) SO₃

10. In the complex with formula MCl₃·4H₂O, the coordination number of the metal M is six and there is no molecule of hydration in it. The volume of 0.1 M AgNO₃ solution needed to precipitate the free chloride ions in 200 mL of 0.01 M solution of the complex is
 (a) 40 mL (b) 20 mL
 (c) 60 mL (d) 80 mL



- 11.** Which of the following is not the correct reaction?

 -
 - $\text{Cl} + 2\text{NH}_3 \rightarrow \text{NH}_2 + \text{NH}_4\text{Cl}$
 - $\text{Cl} + \text{NH}_3 \rightarrow \text{ } + \text{NH}_4\text{Cl}$
 - $\text{NH}_2 + \text{HNO}_2 \xrightarrow{273\text{ K}} \text{OH}$

12. Which of the following statements about alkaline earth metals are correct?

 - Hydration energy of Sr^{2+} is greater than that of Be^{2+} .
 - CaCO_3 decomposes at a higher temperature than BaCO_3 .
 - Ba(OH)_2 is a stronger base than Mg(OH)_2 .
 - SrSO_4 is less soluble in water than CaSO_4 .
 - 4 only
 - 1 and 3
 - 1 and 4
 - 3 and 4

13. Half-lives of first order and zero order reactions are same. Ratio of rates at the start of reaction is

 - 0.693
 - $\frac{1}{0.693}$
 - 2×0.693
 - $\frac{2}{0.693}$

14. Which among the following compounds will give a secondary alcohol on reacting with Grignard reagent followed by acid hydrolysis?

I. HCHO	II. $\text{C}_2\text{H}_5\text{CHO}$
III. CH_3COCH_3	IV. HCOOC_2H_5
(a) II only	(b) III only
(c) I and IV	(d) II and IV

15. In which case addition of $\text{Br}_2/\text{H}_2\text{O}$ is highly regioselective?

 - $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$
 - $(\text{CH}_3)_2\text{C}=\text{CH}_2$
 - $\text{CH}_3\text{CH}=\text{CHCH}_3$
 - $\text{CH}_2=\text{CH}_2$

16. Which of the following species are more resonance stabilised in the following pairs?

[$\text{C}_6\text{H}_5\text{Cl}, \text{C}_6\text{H}_5\text{CH}_3$], [$\text{CH}_2=\text{CHCl}, \text{CH}_2=\text{CHCH}_2\text{Cl}$], [$\text{C}_6\text{H}_5\text{Br}, \text{C}_6\text{H}_5\text{CH}_2\text{Br}$], [$\text{CH}_3\text{COOH}, \text{CH}_3\text{COO}^-$]

 - $\text{C}_6\text{H}_5\text{Cl}, \text{CH}_2=\text{CHCH}_2\text{Cl}, \text{C}_6\text{H}_5\text{CH}_2\text{Br}, \text{CH}_3\text{COO}^-$
 - $\text{C}_6\text{H}_5\text{CH}_3, \text{CH}_2=\text{CHCH}_2\text{Cl}, \text{C}_6\text{H}_5\text{CH}_2\text{Br}, \text{CH}_3\text{COO}^-$

17. Which one of the following is a non-benzenoid aromatic compound?

 - Aniline
 - Benzoic acid
 - Naphthalene
 - Tropolone

18. An element (X) belongs to fourth period and fifteenth group of the periodic table. Which one of the following is true regarding the outer electronic configuration of (X)? It has

 - partially filled d orbitals and completely filled s orbital
 - completely filled s orbital and completely filled p orbitals
 - completely filled s orbital and half-filled p orbitals
 - half-filled d orbitals and completely filled s orbital.

19. Which of the following are true?

 - Sucrose is a non-reducing sugar.
 - Glucose is oxidised by bromine water.
 - Glucose rotates plane polarized light in clockwise direction.
 - Fructose is oxidised by bromine water.
 - (i), (ii), (iii)
 - (i), (ii) only
 - (ii), (iii) only
 - (i), (iv) only

20. For the reaction between MnO_4^- and $\text{C}_2\text{O}_4^{2-}$ in acidic solution, the unbalanced equation is

$$\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} \longrightarrow \text{Mn}^{2+} + \text{CO}_2$$

In a balanced equation, the number of H^+ ions is

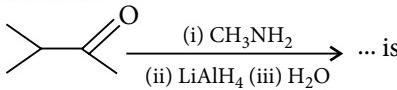
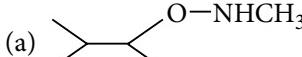
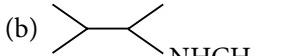
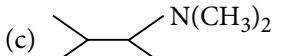
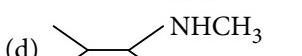
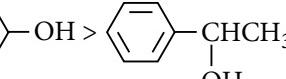
 - 0
 - 4
 - 16
 - 2

21. Synthetic polymer which resembles natural rubber is

 - neoprene
 - chloroprene
 - glyptal
 - nylon.

22. Select the correct statement.

 - Synthetic detergents are alkylbenzene sulphonates.
 - Straight chain alkyl groups are biodegradable while branched chain alkyl groups are not.
 - Phosphates and silicates are added to detergents as 'builders' to complex the hard water cations.
 - All are correct.

- 23.** Given below, catalyst and corresponding process/reaction are matched. The mis-match is
- [RhCl(PPh₃)₃] : Hydrogenation
 - TiCl₄ + Al(C₂H₅)₃ : Polymerization
 - V₂O₅ : Haber-Bosch process
 - Nickel : Hydrogenation
- 24.** $\text{CH}_3\text{COOH} \xrightarrow{\text{Br}_2/\text{P}} X \xrightarrow[\text{(ii) H}_3\text{O}^+]{\text{(i) KCN}} Y$
Y is
- succinic acid
 - malonic acid
 - glycolic acid
 - α -hydroxypropionic acid.
- 25.** During the decomposition of H₂O₂ to give oxygen, 48 g O₂ is formed per minute at a certain point of time. The rate of formation of water at this point is
- 0.75 mol min⁻¹
 - 1.5 mol min⁻¹
 - 2.25 mol min⁻¹
 - 3.0 mol min⁻¹
- 26.** The number of primary, secondary and tertiary carbons in 3,4-dimethylheptane are respectively
- 4, 3 and 2
 - 2, 3 and 4
 - 4, 2 and 3
 - 3, 4 and 2
- 27.** The true statement for the acids of phosphorus, H₃PO₂, H₃PO₃ and H₃PO₄ is
- the order of their acidity is H₃PO₄ > H₃PO₃ > H₃PO₂
 - all of them are reducing in nature
 - all of them are tribasic acids
 - the geometry of phosphorus is tetrahedral in all the three.
- 28.** Which one of the following is not a buffer solution?
- 0.8M H₂S + 0.8M KHS
 - 2M C₆H₅NH₂ + 2M C₆H₅NH₃⁺Br⁻
 - 3M H₂CO₃ + 3M KHCO₃
 - 0.05M KClO₄ + 0.05M HClO₄
- 29.** Which of the following statements is true?
- Cold and very dilute HNO₃ forms NH₄NO₃ with Zn or Sn.
 - Concentrated HNO₃ forms H₂SnO₃ with Sn.
 - Hot and concentrated HNO₃ forms NO₂ with Cu.
 - All are correct.
- 30.** The vitamin most closely associated with carbohydrate metabolism is
- vitamin B₁
 - vitamin B₂
 - vitamin D₂
 - vitamin B₁₂.
- 31.** The volumes of 4 N HCl and 10 N HCl required to make 1 litre of 6 N HCl are
- 0.75 litre of 10 N HCl and 0.25 litre of 4 N HCl
 - 0.25 litre of 4 N HCl and 0.75 litre of 10 N HCl
 - 0.67 litre of 4 N HCl and 0.33 litre of 10 N HCl
 - 0.80 litre of 4 N HCl and 0.20 litre of 10 N HCl
- 32.** Philosopher's wool when heated with BaO at 1100°C gives a compound. Identify the compound.
- BaZnO₂
 - Ba + ZnO₂
 - BaCdO₂
 - BaO₂ + Zn
- 33.** Select the correct statement.
- Geometrical isomer may differ in dipole moment and visible/UV spectra.
 - Complexes of the type [M₃b₃] can also have facial (*fac*) and meridional (*mer*) isomer.
 - No optical isomer exists for the complex *trans*-[Co(en)₂Cl₂]⁺.
 - All of these.
- 34.** The major organic product formed in the following reaction
- 
- (a) 
O-NHCH₃
- (b) 
NHCH₃
- (c) 
N(CH₃)₂
- (d) 
OH
- 35.** The bond dissociation energies of H₂, Cl₂ and HCl are 104, 58 and 103 kcal mol⁻¹ respectively. The enthalpy of formation of HCl would be
- 22 kcal mol⁻¹
 - 44 kcal mol⁻¹
 - +44 kcal mol⁻¹
 - +22 kcal mol⁻¹
- 36.** Which is incorrect order of dehydration of alcohol?
-  - OH >  - OH
 -  - OH >  - CHCH₃
 -  - OH > CH₃CH₂OH
 - CH₃CH₂CHCH₃ > CH₃CH₂CH₂CH₂OH

37. Among the following, the achiral amino acid is
 (a) 2-ethylalanine (b) 2-methylglycine
 (c) 2-hydroxymethylserine
 (d) tryptophan.
38. Which of the underlined atoms in oxyacids have sp^3 hybridised atoms?
 (a) $\underline{\text{HClO}}_4$, $\text{H}_2\underline{\text{SO}}_4$, $\text{H}\underline{\text{NO}}_2$
 (b) $\text{H}_2\underline{\text{SO}}_4$, $\text{H}_3\underline{\text{PO}}_4$, $\text{H}\underline{\text{NO}}_3$
 (c) $\text{H}\underline{\text{ClO}}_4$, $\text{H}_2\underline{\text{SO}}_4$, $\text{H}_2\underline{\text{SO}}_5$
 (d) $\text{H}\underline{\text{ClO}}_4$, $\text{H}\underline{\text{NO}}_3$, $\text{H}\underline{\text{ClO}}_3$
39. Cementite is
 (a) interstitial compound of iron and carbon
 (b) an alloy of Fe and Cr
 (c) a compound resembling cement
 (d) an ore of iron.
40. In alkaline solution HXeO_4^- disproportionates to
 (a) XeO_6^{4-} and Xe (b) XeO_4^{2-} and XeO_3
 (c) XeO_3 and Xe (d) XeO_6^{4-} and XeO_3

ASSERTION AND REASON

- Directions :** In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as :
- (a) If both assertion and reason are true and reason is the correct explanation of assertion.
 (b) If both assertion and reason are true but reason is not the correct explanation of assertion.
 (c) If assertion is true but reason is false.
 (d) If both assertion and reason are false.

41. **Assertion :** Nitrogen is unreactive at room temperature but becomes reactive at elevated temperatures or in presence of a catalyst.

Reason : In nitrogen molecule, there is extensive delocalization of electrons.

42. **Assertion :** In the case of an ideal gas, the changes in Gibbs' and Helmholtz free energies are equal to each other ($\Delta G = \Delta A$) for isothermal reversible processes.

Reason : There is no change in internal energies and enthalpies for ideal gases at constant temperature.

43. **Assertion :** Formic acid reduces mercuric chloride to mercurous chloride on heating while acetic acid does not.

Reason : Formic acid is stronger acid than acetic acid.

44. **Assertion :** Enthalpy changes are positive when $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ and salts like NaCl ,

KCl etc. which do not form hydrates are dissolved in water. But enthalpy changes are negative when anhydrous salts capable of forming hydrates are dissolved in water.

Reason : The difference in the behaviour is due to large differences in the molecular weights of hydrated and anhydrous salts. The substances with larger molecular weights usually show positive enthalpy changes on dissolution.

45. **Assertion :** Acetylene reacts with sodamide to evolve H_2 gas.

Reason : Acetylene is a weaker acid than ammonia.

46. **Assertion :** In electrolysis, the quantity of electricity needed for depositing 1 mole of silver is different from that required for 1 mole of copper.

Reason : The molecular weights of silver and copper are different.

47. **Assertion :** AlCl_3 forms dimer Al_2Cl_6 but it is dissolved in H_2O forming $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ and Cl^- ions.

Reason : Aqueous solution of AlCl_3 is acidic due to hydrolysis.

48. **Assertion :** Oximes are more acidic than hydroxylamines.

Reason : Oximes of aldehydes and ketones show geometrical isomerism.

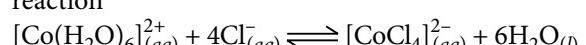
49. **Assertion :** Europium (II) is more stable than cerium (II).

Reason : Cerium salts are used as catalysts in petroleum cracking.

50. **Assertion :** Benzyl bromide when kept in acetone water it produces benzyl alcohol.

Reason : The reaction follows S_N2 mechanism.

51. **Assertion :** On cooling a mixture, colour of the mixture turns to pink from deep blue for a reaction



Reason : Reaction is endothermic, so on cooling, the reaction moves to backward direction.

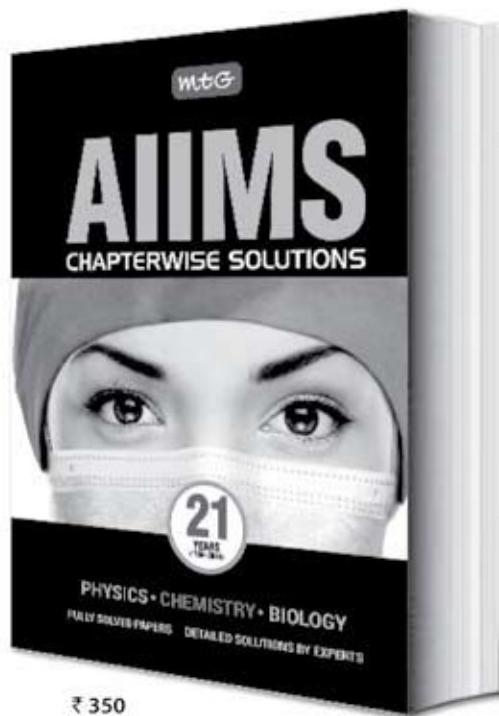
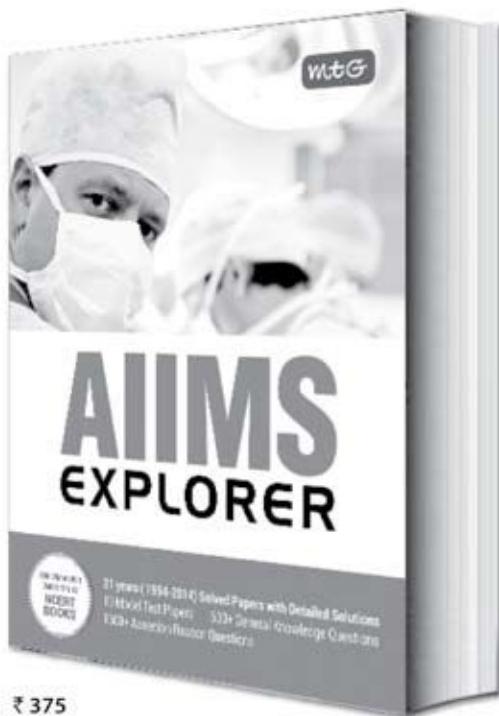
52. **Assertion :** Reduction of *m*-dinitrobenzene with ammonium sulphide gives *m*-nitroaniline.

Reason : *m*-Nitroaniline formed gets precipitated and hence further reduction is prevented.

53. **Assertion :** Orlon is used as synthetic fibres.

Reason : The monomer of orlon is vinyl chloride.

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- Subjectwise distribution of 21 years' questions

- 54. Assertion :** NF_3 is weaker ligand than $\text{N}(\text{CH}_3)_3$.
Reason : NF_3 ionizes to give F^- ions in aqueous solution.
- 55. Assertion :** During digestion with concentrated H_2SO_4 , nitrogen of the organic compound is converted into $(\text{NH}_4)_2\text{SO}_4$.
Reason : $(\text{NH}_4)_2\text{SO}_4$ on heating with alkali liberates NH_3 .
- 56. Assertion :** The micelle formed by sodium stearate in water has $-\text{COO}^-$ groups at the surface.
Reason : Surface tension of water is reduced by the addition of stearate.
- 57. Assertion :** Compressibility factor (Z) for non-ideal gases is always greater than 1.
Reason : Non-ideal gases always exert higher pressure than expected.
- 58. Assertion :** Lassaigne method is used to detect nitrogen, halogen, phosphorus and sulphur in organic compounds.
Reason : Organic compounds being covalents normally do not have ionisable groups, hence, direct test is not possible.
- 59. Assertion :** The addition of catalyst lowers the activation barrier, yet there is no change in the enthalpy change.
Reason : Enthalpy change is equal to the difference in the activation energy for the forward and the backward reactions.
- 60. Assertion :** Hydroxyketones are not directly used in Grignard reaction.
Reason : Grignard reagents react with hydroxyl group.

SOLUTIONS

- 1. (b) :** $\text{CH}_3\text{CHO} \xrightarrow{\text{HCN}} \text{CH}_3\text{CH}(\text{CN})\text{OH}$
- $\downarrow \text{H}_3\text{O}^+$
- $\text{CH}_3\text{CH}(\text{COOH})\text{OH}$
- Lactic acid
- 2. (c) :** According to ideal gas equation,
 $PV = nRT$
- Putting the standard conditions, i.e. $P = 1 \text{ atm}$, $n = 1 \text{ mole}$, $R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$, $T = 273 \text{ K}$
- $$V = \frac{nRT}{P} = \frac{1 \text{ mole} \times 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1} \times 273 \text{ K}}{1 \text{ atm}}$$
- $$V = 22.4 \text{ L}$$

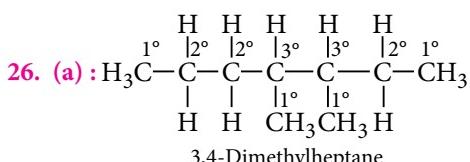
According to Avogadro's hypothesis, equal volumes of different gases contain same number of molecules under similar conditions of temperature and pressure. Thus, 22.4 litres of any gas at N.T.P. will contain one gram mole or its molecular mass in grams.

- 3. (c) :** $\text{Mg}^{2+} + 2e^- \rightarrow \text{Mg}$
- 2F (2×96500) C is required to deposit 24 g of Mg.
 Charge required to deposit 1 g of Mg
- $$= \frac{2 \times 96500}{24} \text{ or } \frac{F}{12}$$
- $\text{Al}^{3+} + 3e^- \rightarrow \text{Al}$
- 3F (3×96500) C of charge is required to deposit 27 g of Al.
 Charge required to deposit 1 g of Al
- $$= \frac{3 \times 96500}{27} \text{ or } \frac{F}{9}$$
- Now, F/12 electricity costs ₹ 10
 F/9 electricity will cost ₹ $\frac{10}{F/12} \times F/9 = ₹ 13.33$
- 4. (b) :** $\text{CH}_3\text{CH}=\text{CHCH}_3$ is symmetrical and gives same product by any of the given methods adopted.
- 5. (a)**
- 6. (a) :** Some important minerals of phosphorus are:
 Hydroxyapatite - $\text{Ca}_5(\text{PO}_4)_3(\text{OH})$ or $\text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2$
 Fluorapatite - $\text{Ca}_5(\text{PO}_4)_3\text{F}$
- 7. (c)**
- 8. (a) :** Reactivity towards electrophilic substitution increases as the electron density in the benzene ring increases. Since $-\text{OCH}_3$ is a strong electron donating group followed by $-\text{CH}_3$ while $-\text{CF}_3$ is a strong electron withdrawing group therefore, the correct decreasing order of reactivity is III > I > II > IV.
- 9. (b) :** Dipole moment in the molecule depends upon the charge and the distance between the charges. As oxygen is more electronegative than nitrogen, iodine or sulphur, it will have greater dipole moment.
- 10. (b) :** The complex with formula $\text{MCl}_3 \cdot 4\text{H}_2\text{O}$, with no molecule of hydration is $[\text{MCl}_2(\text{H}_2\text{O})_4]\text{Cl}$, so one chlorine is ionisable.
 \therefore No. of equivalents of Ag^+ = No. of equivalents of Cl^- in solution.
 $0.1 \times V = 0.01 \times 200$
 $\therefore V = \frac{2}{0.1} = 20 \text{ mL}$

$$\therefore 48 \text{ g of O}_2 \text{ will be obtained from } \frac{2 \times 34}{32} \times 48 \text{ g of H}_2\text{O}_2 \\ = 102 \text{ g of H}_2\text{O}_2$$

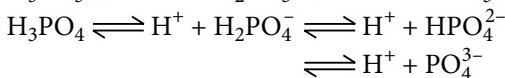
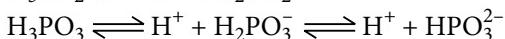
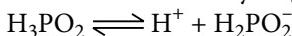
Rate of formation of H₂O = Rate of decomposition of H₂O₂

$$\therefore \text{Rate of formation of H}_2\text{O} = \frac{102}{34} \text{ mol min}^{-1} \\ = 3 \text{ mol min}^{-1}$$

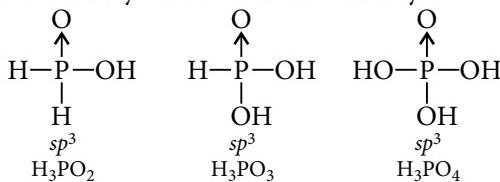


There are four 1° C-atoms, three 2° C-atoms and two 3° C-atoms.

27. (d) : H₃PO₂, H₃PO₃ and H₃PO₄ contain one, two and three ionisable hydrogen atoms respectively.



But there is very little difference in acidity.



As P is sp^3 hybridised in all therefore all are tetrahedral.

28. (d) : Buffer solutions can be obtained by mixing a weak acid with its salt formed with a strong base or by mixing a weak base with its salt formed with a strong acid.

As HClO₄ is a strong acid, therefore equimolar mixture of HClO₄ and its salt KClO₄ is not a buffer solution.

29. (d)

30. (a)

31. (c) : When two solutions of the same solute are mixed, normality of the given mixture is

$$N_3 = \frac{N_1 V_1 + N_2 V_2}{V_1 + V_2} \quad \dots(i)$$

Also, if two solutions of different normalities are mixed, the normality of the resulting solution can be calculated as

$$N_1 V_1 + N_2 V_2 = N_3 V_3$$

Given, N₁ = 4 N, N₂ = 10 N, V₁ = ?, V₂ = ?

$$N_3 = 6 \text{ N}, V_3 = 1 \text{ litre}$$

Substituting the above values in (i)

$$6 = \frac{4V_1 + 10V_2}{V_1 + V_2} \Rightarrow 6V_1 + 6V_2 = 4V_1 + 10V_2 \quad \dots(ii)$$

$$\Rightarrow 3V_1 + 3V_2 = 2V_1 + 5V_2 \quad \dots(iii)$$

$$\Rightarrow V_1 = 2V_2$$

Substituting in (ii)

$$4V_1 + 10V_2 = 6 \quad (\because V_1 + V_2 = 1 \text{ L})$$

$$\Rightarrow 2V_1 + 5V_2 = 3 \quad \dots(iv)$$

$$\text{From (iii), } V_1 = 2V_2$$

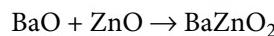
$$\therefore (2 \times 2V_2) + 5V_2 = 3$$

$$\Rightarrow 4V_2 + 5V_2 = 3 \Rightarrow 9V_2 = 3$$

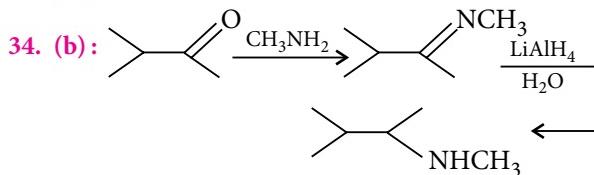
$$\Rightarrow V_2 = \frac{1}{3} = 0.33 \text{ L and}$$

$$\therefore V_1 = 2 \times 0.33 = 0.66 \text{ L}$$

32. (a) : When Philosopher's wool (*i.e.* ZnO) is heated with BaO at 1100°C, it gives BaZnO₂.



33. (d)



35. (a) : $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$

Bond dissociation energy of H₂ = 104 kcal mol⁻¹

Bond dissociation energy of Cl₂ = 58 kcal mol⁻¹

Bond dissociation energy of HCl = 103 kcal mol⁻¹

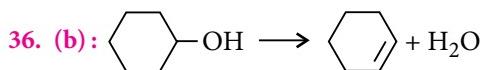
Using $\Delta H_{\text{reaction}}^\circ = \sum H_{\text{reactant}}^\circ - \sum H_{\text{product}}^\circ$

$$= (104 + 58) - 2 \times 103$$

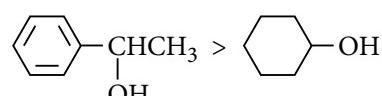
$$= 162 - 206 = -44 \text{ kcal mol}^{-1}$$

This is enthalpy of formation of 2 moles of HCl.

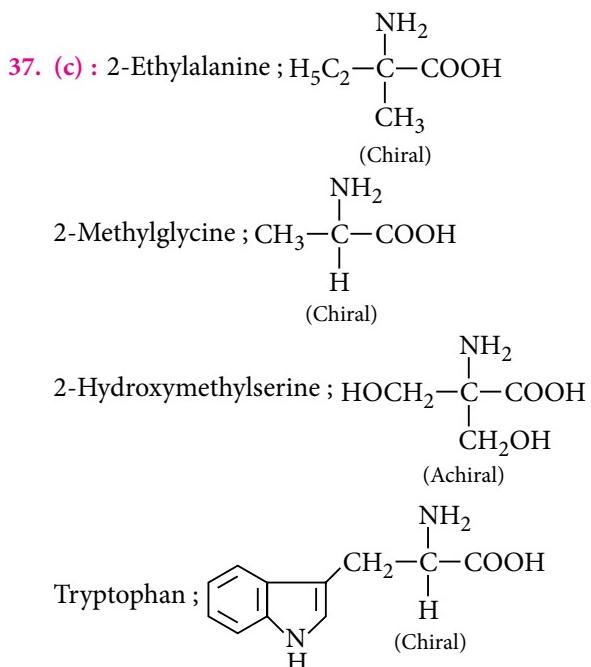
Thus enthalpy of formation of HCl = -22 kcal mol⁻¹



This dehydration takes place through the formation of resonance stabilised carbocation. Thus,

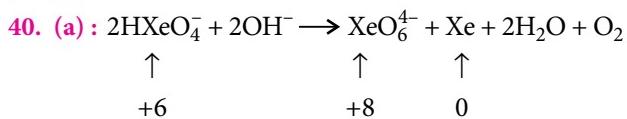


Thus (b) is incorrect.



38. (c) : Oxyacids of nitrogen are sp^2 -hybridised.
Thus HNO_2 and HNO_3 are not sp^3 -hybridised.

39. (a)

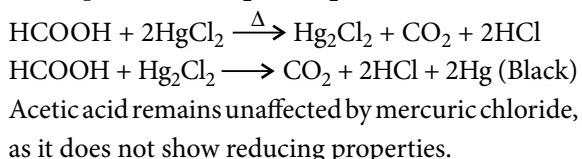


Thus, HXeO_4^- disproportionates to XeO_6^{4-} (by oxidation) and Xe (by reduction).

41. (b) : Due to small size and high dissociation energy (946 kJ mol^{-1}) of nitrogen, it is unreactive.

42. (b)

43. (b) : Formic acid behaves as reducing agent as it is oxidised to an unstable carbonic acid, which decomposes into CO_2 and H_2O .



44. (c) : The exothermic or endothermic behaviour of dissolution depends upon the nature of the salt and not on its molecular weight.

45. (c) : Acetylene is a stronger acid than ammonia.

46. (b) : 1 mole of Ag = 1 g equivalent of Ag
but 1 mole of Cu = 2 g equivalents of copper.

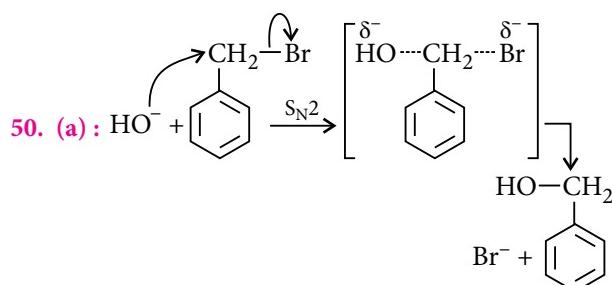
47. (b)

48. (b) : Oximes are more acidic because there is delocalisation of π -electrons (i.e. resonance) and it stabilises it and its conjugate acid. But no such resonance exists in hydroxylamine base (NH_2O^-).

49. (b) : The electronic configurations of europium (II) and cerium (II) are



In Eu^{2+} , f -subshell is half-filled.



51. (a) : $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$ is pink while $[\text{CoCl}_4]^{2-}$ is blue. So, on cooling, because of Le Chatelier's principle, the reaction tries to overcome the effect of temperature.

52. (c) : The overall electron deficiency in *m*-nitroaniline is much less (due to $-R$ effect of NO_2 group and $+R$ effect of NH_2 group) than in *m*-dinitrobenzene ($-R$ effect of two NO_2 groups) and hence does not accept additional electrons from weak reducing agent such as $(\text{NH}_4)_2\text{S}$ and thus further reduction is prevented.

53. (c) : The monomer of orlon is acrylonitrile.

54. (c) : F being more electronegative, attracts the electrons of N towards itself and thus NF_3 is poor donor and weaker ligand.

55. (b) : During digestion with concentrated H_2SO_4 , N and H of the organic compound combine to form NH_3 which being basic dissolves in H_2SO_4 to form $(\text{NH}_4)_2\text{SO}_4$.

56. (b) : Micelle is formed if molecules with polar and non-polar ends assemble in bulk to give non-polar interior and polar exterior.

57. (d) : Z can be greater than 1 or less than 1. Non-ideal gases exert less pressure than expected due to backward pull by other molecules.

58. (a)

59. (a)

60. (a) : Grignard reagents are very reactive. Hence the Grignard reagents will react with hydroxyl group.



JEE MAIN

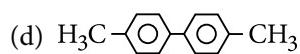
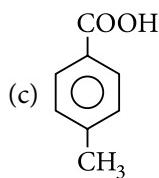
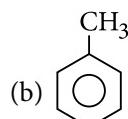
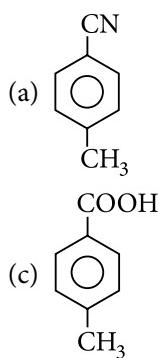
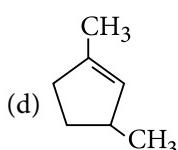
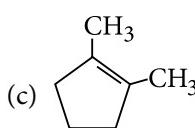
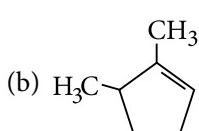
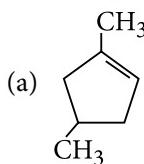
SOLVED PAPER 2015



We are happy to inform our readers that $\approx 50\%$ questions asked in 2015 JEE Exam are from **MTG JEE Main Chemistry**. Many Questions in this year's exam were similar in nature to the problems given in this book.



1. Which compound would give 5-keto-2-methylhexanal upon ozonolysis?



2. Which of the vitamins given below is water soluble?

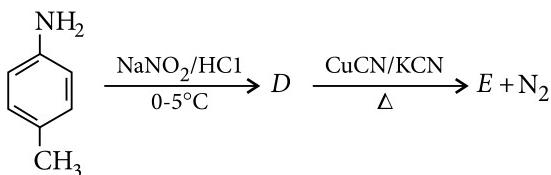
- (a) Vitamin E (b) Vitamin K
(c) Vitamin C (d) Vitamin D

[From MTG JEE Main Chemistry,
Similar Question, Page 1218, Q-4]

3. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy?

- (a) BaSO_4 (b) SrSO_4
(c) CaSO_4 (d) BeSO_4

4. In the reaction,



The product (*E*) is

5. Sodium metal crystallizes in a body centred cubic lattice with a unit cell edge of 4.29 \AA . The radius of sodium atom is approximately

- (a) 5.72 \AA (b) 0.93 \AA
(c) 1.86 \AA (d) 3.22 \AA

[From MTG JEE Main Chemistry,
Similar Question, Page 278, Q-28]

6. Which of the following compounds is not yellow coloured?

- (a) $(\text{NH}_4)_3[\text{As}(\text{Mo}_3\text{O}_{10})_4]$
(b) BaCrO_4
(c) $\text{Zn}_2[\text{Fe}(\text{CN})_6]$ (d) $\text{K}_3[\text{Co}(\text{NO}_2)_6]$

7. Which of the following is the energy of a possible excited state of hydrogen?

- (a) -3.4 eV (b) $+6.8\text{ eV}$
(c) $+13.6\text{ eV}$ (d) -6.8 eV

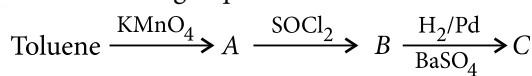
[From MTG JEE Main Chemistry,
Page 95, Q-29]

8. Which of the following compounds is not an antacid?
- Phenelzine
 - Ranitidine
 - Aluminium hydroxide
 - Cimetidine
9. The ionic radii (in Å) of N³⁻, O²⁻ and F⁻ are respectively
- 1.71, 1.40 and 1.36
 - 1.71, 1.36 and 1.40
 - 1.36, 1.40 and 1.71
 - 1.36, 1.71 and 1.40

[From MTG JEE Main Chemistry,
Similar Question, Page 475, Q-15]

10. In the context of the Hall-Heroult process for the extraction of Al, which of the following statements is false?
- Al³⁺ is reduced at the cathode to form Al.
 - Na₃AlF₆ serves as the electrolyte.
 - CO and CO₂ are produced in this process.
 - Al₂O₃ is mixed with CaF₂ which lowers the melting point of the mixture and brings conductivity.

11. In the following sequence of reactions :



the product (C) is

- C₆H₅CH₂OH
- C₆H₅CHO
- C₆H₅COOH
- C₆H₅CH₃

[From MTG JEE Main Chemistry,
Similar Question, Page 956, Q-18]

12. Higher order (>3) reactions are rare due to
- shifting of equilibrium towards reactants due to elastic collisions
 - loss of active species on collision
 - low probability of simultaneous collision of all the reacting species
 - increase in entropy and activation energy as more molecules are involved.

13. Which of the following compounds will exhibit geometrical isomerism?
- 2-Phenyl-1-butene
 - 1, 1-Diphenyl-1-propane
 - 1-Phenyl - 2 - butene
 - 3-Phenyl-1-butene

[From MTG JEE Main Chemistry,
Page 881, Q-86]

14. Match the catalysts to the correct processes.

Catalyst	Process
(A) TiCl ₄	(i) Wacker process
(B) PdCl ₂	(ii) Ziegler-Natta polymerization
(C) CuCl ₂	(iii) Contact process
(D) V ₂ O ₅	(iv) Deacon's process
(a) (A) - (ii), (B) - (iii), (C) - (iv), (D) - (i)	
(b) (A) - (iii), (B) - (i), (C) - (ii), (D) - (iv)	
(c) (A) - (iii), (B) - (ii), (C) - (iv), (D) - (i)	
(d) (A) - (ii), (B) - (i), (C) - (iv), (D) - (iii)	

15. The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is

- London force
- hydrogen bond
- ion - ion interaction
- ion - dipole interaction.

16. The molecular formula of a commercial resin used for exchanging ions in water softening is C₈H₇SO₃Na (Mol. wt. 206). What would be the maximum uptake of Ca²⁺ ions by the resin when expressed in mole per gram resin?

- $\frac{2}{309}$
- $\frac{1}{412}$
- $\frac{1}{103}$
- $\frac{1}{206}$

17. Two faradays of electricity are passed through a solution of CuSO₄. The mass of copper deposited at the cathode is (at. mass of Cu = 63.5 amu)
- 2 g
 - 127 g
 - 0 g
 - 63.5 g

18. The number of geometric isomers that can exist for square planar [Pt(Cl)(py)(NH₃)(NH₂OH)]⁺ is (py = pyridine)

- 4
- 6
- 2
- 3

[From MTG JEE Main Chemistry,
Similar Question, Page 748, Q-62]

19. In Carius method of estimation of halogens, 250 mg of an organic compound gave 141 mg of AgBr. The percentage of bromine in the compound is (at. mass Ag = 108; Br = 80)

- 48
- 60
- 24
- 36

[From MTG JEE Main Chemistry,
Similar Question, Page 793, Q-4]

20. The colour of KMnO₄ is due to

- L → M charge transfer transition
- σ → σ* transition
- M → L charge transfer transition
- d - d transition.

- 21.** The synthesis of alkyl fluorides is best accomplished by

 - (a) Finkelstein reaction
 - (b) Swart's reaction
 - (c) free radical fluorination
 - (d) Sandmeyer's reaction.

22. 3 g of activated charcoal was added to 50 mL of acetic acid solution (0.06N) in a flask. After an hour it was filtered and the strength of the filtrate was found to be 0.042 N. The amount of acetic acid adsorbed (per gram of charcoal) is

 - (a) 12.6
 - (b) 7.5
 - (c) 15.0
 - (d) 3.0

[From MTG JEE Main Chemistry, Similar Question, Page 321, Q-3]

- 24.** Which among the following is the most reactive?

(a) I₂ (b) ICl (c) Cl₂ (d) Br₂

25. The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2 J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, $[B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the $[R = 8.314 \text{ J/K/mol}, e = 2.718]$

(a) forward direction because $Q < K_c$
 (b) reverse direction because $Q < K_c$
 (c) forward direction because $Q > K_c$
 (d) reverse direction because $Q > K_c$.

26. Assertion : Nitrogen and oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.

Reason : The reaction between nitrogen and oxygen requires high temperature.

- (a) The assertion is incorrect, but the reason is correct.
 - (b) Both the assertion and reason are incorrect.
 - (c) Both assertion and reason are correct and the reason is the correct explanation for the assertion.
 - (d) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion.

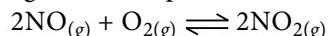
27. Which one has the highest boiling point?
(a) Kr (b) Xe (c) He (d) Ne

- 28.** Which polymer is used in the manufacture of paints and lacquers?

 - (a) Polypropene
 - (b) Polyvinyl chloride
 - (c) Bakelite
 - (d) Glyptal

[From MTG JEE Main Chemistry, Similar Question, Page 1191, Q-21]

- 29.** The following reaction is performed at 298 K.



The standard free energy of formation of $\text{NO}_{(g)}$ is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $\text{NO}_{2(g)}$ at 298 K? ($K_p = 1.6 \times 10^{12}$)

- (a) $8660 - \frac{\ln(1.6 \times 10^{12})}{R(298)}$

(b) $0.5[2 \times 86,600 - R(298)\ln(1.6 \times 10^{12})]$

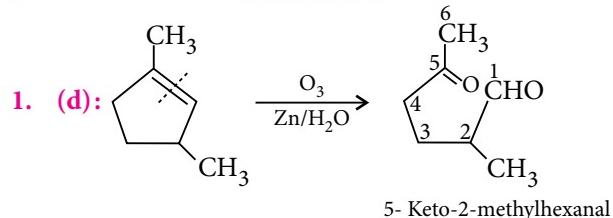
(c) $R(298)\ln(1.6 \times 10^{12}) - 86600$

(d) $86600 + R(298)\ln(1.6 \times 10^{12})$

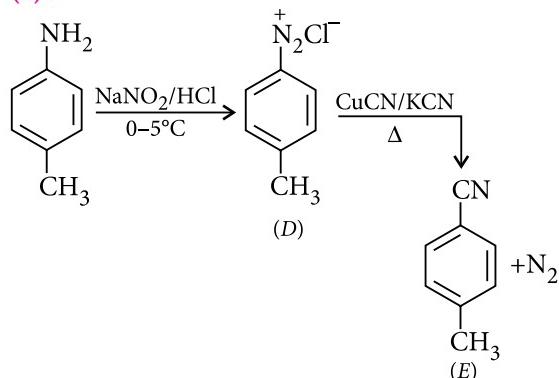
30. From the following statements regarding H_2O_2 , choose the incorrect statement.

 - (a) It has to be stored in plastic or wax lined glass bottles in dark.
 - (b) It has to be kept away from dust .
 - (c) It can act only as an oxidizing agent.
 - (d) It decomposes on exposure to light.

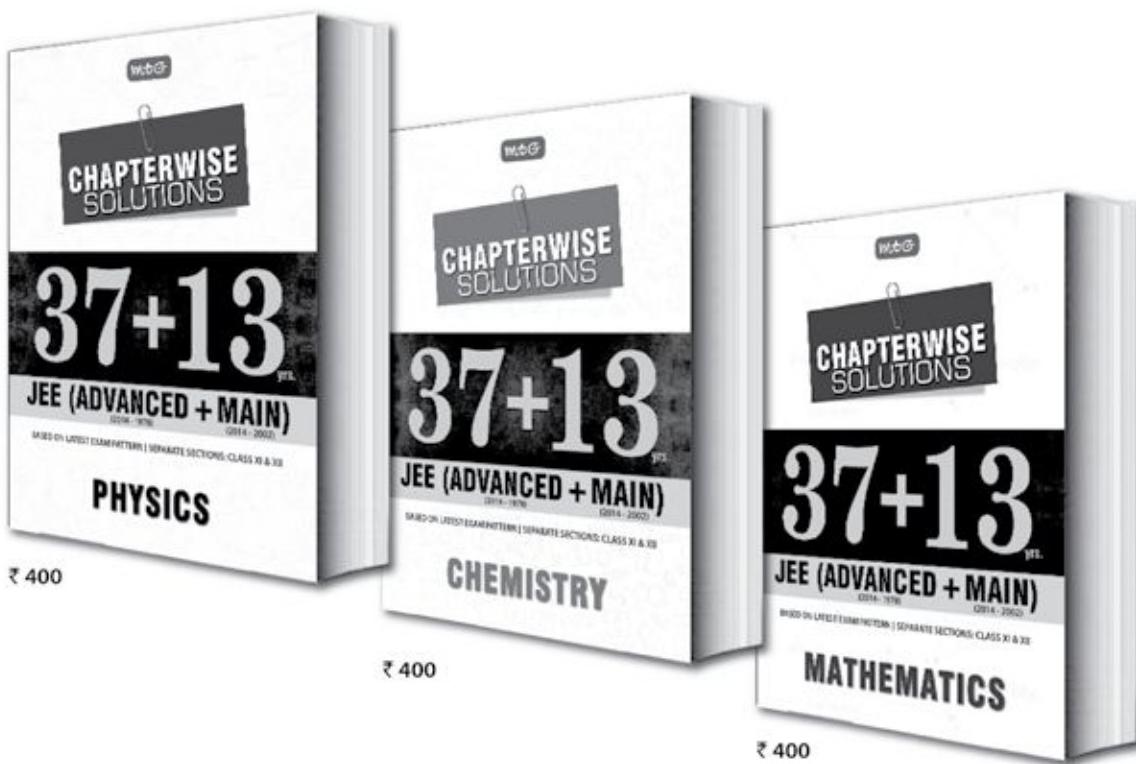
SOLUTIONS



2. (c): Vitamin C is water soluble while vitamin E, K and D are fat soluble.
 3. (d): Be^{2+} being smaller in size has maximum hydration enthalpy which exceeds its lattice enthalpy.
 4. (a):



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5. (c) : For bcc, $r = \frac{\sqrt{3}}{4} a$

$$r = \frac{\sqrt{3}}{4} \times 4.29 = 1.86 \text{ \AA}$$

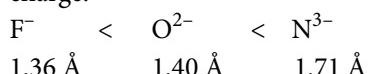
6. (c) : $\text{Zn}_2[\text{Fe}(\text{CN})_6]$ is bluish white while all others are yellow coloured.

7. (a) : Energy of electron in the n^{th} orbit of H-atom is,

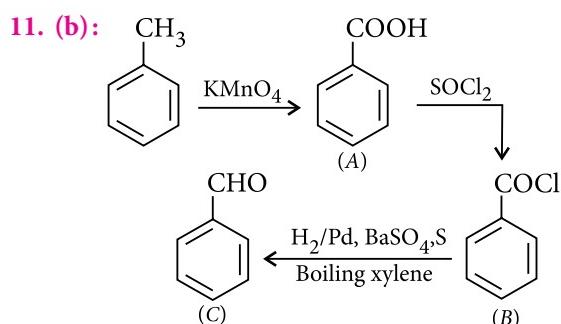
$$E_n = \frac{-13.6}{n^2} \text{ eV} = \frac{-13.6}{2^2} = 3.4 \text{ eV}$$

8. (a) : Phenelzine is a tranquilizer (antidepressant drug). Ranitidine, aluminium hydroxide and cimetidine are antacids.

9. (a) : The ionic radii of isoelectronic ions increase with the decrease in magnitude of the nuclear charge.



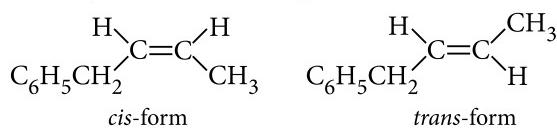
10. (b) : In Hall – Heroult process for the extraction of Al, electrolyte is Al_2O_3 dissolved in Na_3AlF_6 containing a little of CaF_2 .



12. (c) : The reactions of higher order are very rare because of the less chances of the molecules to come together simultaneously and collide.

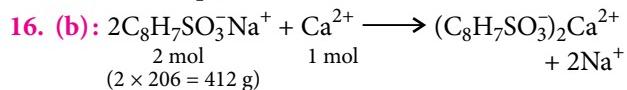
13. (c) : For geometrical isomerism, the molecule must contain a double bond and each of the two carbon atoms of the double bond must have different substituents which may be same or different. Thus, alkenes of the type $abc = Cab$ and $abC = Cde$ show geometrical isomerism.

1-Phenyl-2-butene shows geometrical isomerism.



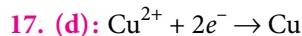
14. (d)

15. (b) : Dipole-dipole interaction (hydrogen bonding) is proportional to $1/r^3$, where r is the distance between the polar molecules.



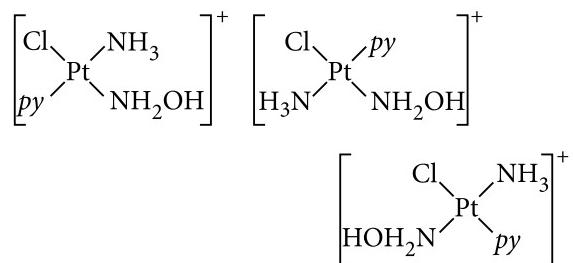
1 mol of $\text{Ca}^{2+} \equiv 412 \text{ g of resin}$

$$\begin{aligned} \text{Maximum uptake of } \text{Ca}^{2+} \text{ ions by the resin} &= \frac{1 \text{ mol}}{412 \text{ g}} \\ &= \frac{1}{412} \text{ mol/g} \end{aligned}$$



2 F charge deposit 1 mol of Cu i.e., 2 F of electricity deposit 63.5 g mass of Cu at the cathode.

18. (d) : The number of geometrical isomers for square planar are 3.



19. (c) : % of Br = $\frac{80}{188} \times \frac{\text{Mass of AgBr formed}}{\text{Mass of substance taken}} \times 100$

$$= \frac{80}{188} \times \frac{141}{250} \times 100 = 24$$

20. (a) : The deep purple colour of KMnO_4 is not due to $d-d$ transitions but due to charge transfer from O to Mn (*i.e.* $L \rightarrow M$), which reduces the oxidation state of Mn from +7 to +6 momentarily.

21. (b) : Alkyl fluorides are more conveniently prepared indirectly by heating suitable chloro or bromoalkanes with inorganic fluorides, such as AsF_3 , SbF_3 , CoF_3 , AgF , Hg_2F_2 , etc.
 $\text{CH}_3\text{Br} + \text{AgF} \rightarrow \text{CH}_3\text{F} + \text{AgBr}$
 This reaction is called Swart's reaction.

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22. (c): No. of milliequivalents of acetic acid initially taken = $(0.06 \text{ N}) \times (50 \text{ mL}) = 3 \text{ meq}$
 No. of milliequivalents of acetic acid left in the filtrate = $(0.042 \text{ N}) \times (50 \text{ mL}) = 2.1 \text{ meq}$
 No. of milliequivalents of acetic acid adsorbed by activated charcoal
 $= (3 - 2.1) = 0.9 \text{ meq}$

Amount of acetic acid adsorbed by 3 g of activated charcoal = $0.9 \times 60 = 54 \text{ mg}$
 Amount of acetic acid adsorbed by 1 g of activated charcoal $\frac{54}{3} = 18 \text{ mg}$

23. (d):
$$\frac{P^{\circ} - P_s}{P^{\circ}} = \frac{w_2 M_1}{w_1 M_2}$$

Given : $P^{\circ} = 185 \text{ torr}$, $w_1 = 100 \text{ g}$, $w_2 = 1.2 \text{ g}$, $P_s = 183 \text{ torr}$

$$M_1 = M_{\text{CH}_3\text{COCH}_3} = 58 \text{ g mol}^{-1}$$

$$\frac{185 - 183}{185} = \frac{1.2 \times 58}{100 \times M_2}$$

$$\Rightarrow M_2 = \frac{1.2 \times 58 \times 185}{100 \times 2} = 64.38 \approx 64 \text{ g mol}^{-1}$$

24. (b): Interhalogen compounds are generally more reactive than the halogens (except F_2).

25. (d): $2A \rightleftharpoons B + C$

Given : $T = 300 \text{ K}$, $\Delta G^{\circ} = 2494.2 \text{ J}$, $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$

$$\Delta G^{\circ} = -2.303 RT \log K_c$$

$$2494.2 = -2.303 \times 8.314 \times 300 \times \log K_c$$

$$\log K_c = \text{antilog } (-0.4342)$$

$$K_c = 0.3679$$

$$Q_c = \frac{[B][C]}{[A]^2} = \frac{2 \times \frac{1}{2}}{\left(\frac{1}{2}\right)^2} = 4$$

Here, $Q_c > K_c$ thus, the reaction will proceed in the backward direction.

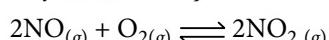
26. (c): Dinitrogen and dioxygen combine to form nitric oxide when the mixture is heated to $2273 - 3273 \text{ K}$ in an electric arc.

27. (b): Boiling point increases down the group from He to Rn due to increase in van der Waals' forces of attraction as the size of the atom increases.

28. (d):

29. (b): Given : $T = 298 \text{ K}$, $\Delta G_f^{\circ}(\text{NO}) = 86.6 \text{ kJ/mol}$,

$$\Delta G_f^{\circ}(\text{NO}_2) = ?, K_p = 1.6 \times 10^{12}$$



$$\Delta G_r^{\circ} = 2\Delta G_f^{\circ}(\text{NO}_2) - 2\Delta G_f^{\circ}(\text{NO}) - \Delta G_f^{\circ}(\text{O}_2)$$

$$\Delta G_r^{\circ} = 2\Delta G_f^{\circ}(\text{NO}_2) - 2 \times 86,600$$

$$\Delta G_r^{\circ} = -RT \ln K_p$$

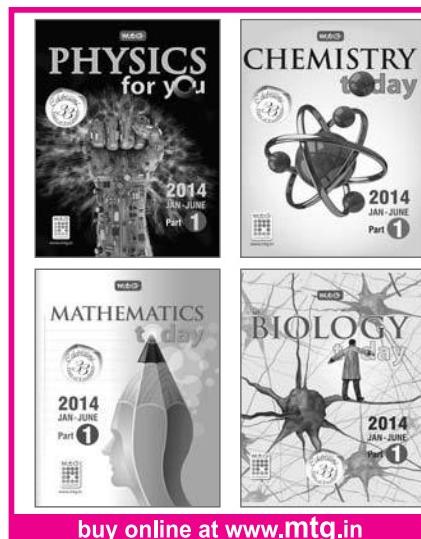
$$2\Delta G_f^{\circ}(\text{NO}_2) - 2 \times 86,600 = -R(298) \ln (1.6 \times 10^{12})$$

$$\Delta G_f^{\circ}(\text{NO}_2) = \frac{2 \times 86,600 - R(298) \ln (1.6 \times 10^{12})}{2}$$

30. (c): H_2O_2 acts as an oxidising as well as a reducing agent.



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CONCEPT MAP

ESSENTIALS OF CHEMISTRY

Some important formulae, trends and terms for a 'quick recap'.

Class XII

Physical Chemistry

The Solid State

- Density of unit cell: $d = \frac{Z \times M}{a^3 \times N_A} \text{ g cm}^{-3}$

- Total no. of atoms per unit cell:

sc	bcc	fcc
$8 \times \frac{1}{8} = 1$	$8 \times \frac{1}{8} + 1 \times 1 = 2$	$8 \times \frac{1}{8} + 6 \times \frac{1}{2} = 4$

- Relation between d , a and r

$$sc : r = \frac{d}{2} = \frac{a}{2}; fcc : r = \frac{d}{2} = \frac{a}{2\sqrt{2}}; bcc : r = \frac{d}{2} = \frac{\sqrt{3}a}{4}$$

- Coordination number and packing efficiency

sc: CN = 6, PE = 52.4%; bcc: CN = 8, PE = 68%; fcc: CN = 12, PE = 74%

- Size and no. of voids:

Type	Size	No. of Voids
Octahedral	$0.414 R$	N
Tetrahedral	$0.225 R$	$2N$

Solutions

- Expression for concentration of a solution:

$$M = \frac{w_2 \times 1000}{M_2 \times V_{(\text{in mL})}}; N = \frac{w_2 \times 1000}{E_2 \times V_{(\text{in mL})}}$$

$$x_2 = \frac{n_2}{n_1 + n_2}, x_1 = \frac{n_1}{n_1 + n_2}; \text{ppm} = \frac{w_2}{M_{\text{soln}}} \times 10^6$$

- On mixing solutions: $N_1 V_1 + N_2 V_2 = N_3 (V_1 + V_2)$; $M_1 V_1 + M_2 V_2 = M_3 (V_1 + V_2)$

- For liquid solutions: $p_A = x_A \times p_A^\circ$; $p_B = x_B \times p_B^\circ$

$$P_{\text{total}} = p_A + p_B; y_A = \frac{p_A}{p_A + p_B}, y_B = 1 - y_A$$

- Colligative properties: $\Delta T_b = iK_b \times m$

$$\Delta T_f = iK_f \times m; \pi = i \frac{n}{V} RT; \frac{p^\circ - p_s}{p^\circ} = ix_2$$

$$\alpha_{(\text{disso.})} = \frac{i-1}{n-1}; \alpha_{(\text{asso.})} = (1-i) \frac{n}{n-1}$$

$$i = \frac{M_c}{M_o} \text{ or } \frac{C_o}{C_c} \text{ (where } M = \text{molar mass, } C = \text{colligative property)}$$

Electrochemistry

- $R = \frac{V}{I}; G = \frac{1}{R}; \rho = R \frac{a}{l}; \kappa = G \times \frac{l}{a}$

- $\Lambda_{eq} = \kappa \times V = \kappa \times \frac{1000}{N}; \Lambda_m = \kappa \times V = \kappa \times \frac{1000}{M}$

- $\Lambda_m^c = \Lambda_m^\infty - b\sqrt{C}; \Lambda_{eq}^\infty = \lambda_c^\infty + \lambda_a^\infty; \Lambda_m^\infty = x\lambda_c^\infty + y\lambda_a^\infty$

- $\alpha = \frac{\Lambda_m^c}{\Lambda_m^\infty}; \Delta G^\circ = -nFE_{\text{cell}}^\circ = -RT \ln K_c$

- $W = ZIt; \frac{W_1}{W_2} = \frac{E_1}{E_2}; E_{\text{cell}}^\circ = E_{\text{(cathode)}}^\circ - E_{\text{(anode)}}^\circ$

- $E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{0.0591}{n} \log \frac{1}{[M^{n+}]}; E_{\text{cell}}^\circ = \frac{0.0591}{n} \log K_c$

Chemical Kinetics

- Expressions for different orders:

Rate law	Integrated rate law	Half-life
Rate = $k[A]^0$ [0 order]	$[A]_t = -kt + [A]_0$	$t_{1/2} = [A]_0 / 2k$
Rate = $k[A]^1$ [1 st order]	$\ln[A]_t = -kt + \ln[A]_0$	$t_{1/2} = 0.693 k$
Rate = $k[A]^2$ [2 nd order]	$1/[A]_t = kt + 1/[A]_0$	$t_{1/2} = 1/k[A]_0$
Rate = $k[A][B]$ [2 nd order]	$kt = \frac{1}{[A]_0 - [B]_0} \ln \frac{[B]_0 - [A]_t}{[A]_0 - [B]_0}$	$t_{1/2} = 1/k[A]_0$
Rate = $k[A]^n$ [n th order]	$(n-1)kt = \frac{1}{[A]^{n-1}} - \frac{1}{[A]_0^{n-1}}$	$t_{1/2} = \frac{2^{n-1} - 1}{k(n-1)[A]_0^{n-1}}$

- Arrhenius equation:

$$k = Ae^{-E_a/RT}; \log \frac{k_2}{k_1} = \frac{E_a}{2.303 R} \left[\frac{T_2 - T_1}{T_1 T_2} \right]$$

Surface Chemistry

- vely charged sols: Metals, sulphides, acidic dyes, starch, clay, silk.
- +vely charged sols: Metal hydroxides, oxides, basic dyes, haemoglobin.
- Hardy-Schulze rule: Coagulation power for -vely charged sols: $Al^{3+} > Ba^{2+} > Na^+$
+vely charged sols: $[Fe(CN)_6]^{4-} > PO_4^{3-} > SO_4^{2-} > Cl^-$

Inorganic Chemistry

General Principles and Processes of Isolation of Elements

Main steps involved in extraction of metals:

- Concentration of the ore: *Hydraulic separation*: for oxide ores; *Froth floatation*: for sulphide ores; *Electromagnetic separation*: for magnetic impurities/ores; *Leaching*: chemical method
- Conversion of ore to oxide: *Calcination*: for carbonates and hydrated oxides; *Roasting*: for sulphide ores.
- Reduction of oxide into free metal: *Smelting*: Reduction with carbon; *Alumino-thermite process*: Reduction with Al; *Auto-reduction*: for less electropositive metals; *Electrometallurgy*: Electrolysis of fused oxide
- Refining of crude metal: *Liquation*: for metals having low b.p.t.s.; *Distillation*: for volatile metals; *Poling*: for metals having own oxides as impurities; *Electrorefining*: for Cu, Ag, Au, Ni, Cr, Al; *Zone refining*: for Si, Ge, Ga; *van-Arkel method*: for Ti, Zr; *Chromatography*: for elements available in minute quantities.

The p-Block Elements

Group 15 (Nitrogen family):

- Bond angle, Thermal stability and Basic strength: $NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$
- B.Pt.: $PH_3 < AsH_3 < NH_3 < SbH_3 < BiH_3$
- M.Pt.: $PH_3 < AsH_3 < SbH_3 < NH_3$
- Reducing nature: $NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$
- Bond angle: $PF_3 < PCl_3 < PBr_3 < PI_3$
- Lewis acid strength: $PCl_3 > AsCl_3 > SbCl_3; PF_3 > PCl_3 > PBr_3 > PI_3$

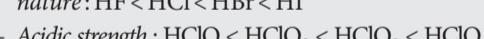
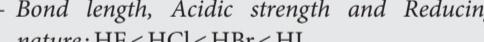
Group 16 (Oxygen family): Bond angle and Thermal stability: $H_2O > H_2S > H_2Se > H_2Te$

- Volatility: $H_2S > H_2Se > H_2Te > H_2O$
- Acidic strength and Reducing nature:



Group 17 (Halogen family):

- Oxidizing power: $F_2 > Cl_2 > Br_2 > I_2$
- B.Pt. and M.Pt.: $HF > HCl > HBr > HI$
- Dipole moment and Thermal stability:



Group 18 (Noble gases): M.Pt., B.Pt., Ease of liquefaction, Solubility, Adsorption and Polarizability: $He < Ne < Ar < Kr < Xe$



d- and f-Block Elements

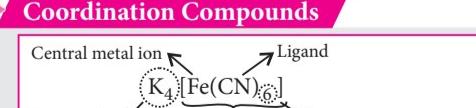
d-block elements: $(n-1)d^{1-10}ns^{0-2}$

- 3d series: $_{21}Sc - _{30}Zn$
- 4d series: $_{39}Y - _{48}Cd$; 5d series: $_{57}La - _{72}Hf - _{80}Hg$
- 6d series: $_{89}Ac - _{104}Rf - _{112}Cn$
- Acidic character: $MnO < Mn_3O_4 < Mn_2O_3 < MnO_2 < Mn_2O_7$
- Ionic character: $MnO > Mn_3O_4 > Mn_2O_3 > MnO_2 > Mn_2O_7$

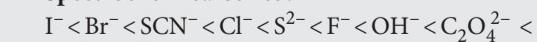
f-block elements: $(n-2)f^{1-14}(n-1)d^{0-1}ns^{0-2}$

- $La(OH)_3$ to $Lu(OH)_3$: Basicity decreases; La^{3+} to Lu^{3+} : Tendency to form complexes increases

Coordination Compounds



Spectrochemical series:



$$\mu = \sqrt{n(n+2)} \text{ B.M.}; \Delta_t = \frac{4}{9} \Delta_o;$$

$$CFSE = (-0.4x + 0.6y)\Delta_o \text{ where, } x = \text{no. of } e^- \text{ s in } t_{2g} \text{ orbitals, } y = \text{no. of } e^- \text{ s in } e_g \text{ orbitals.}$$

Organic Chemistry

Haloalkanes and Haloarenes

- Reactivity order: $RI > RBr > RCl; 3^\circ > 2^\circ > 1^\circ; S_N1 \text{ reaction: } 3^\circ > 2^\circ > 1^\circ; S_N2 \text{ reaction: } 1^\circ > 2^\circ > 3^\circ$
- Dipole moments:
 - $CH_3Cl > CH_3F > CH_3Br > CH_3I$
 - $CH_3Cl > CH_2Cl_2 > CHCl_3 > CCl_4 \text{ (zero)}$
 - $\text{o-Dichlorobenzene} > \text{m-dichlorobenzene} \approx \text{chlorobenzene} > \text{p-dichlorobenzene (zero)}$

Alcohols, Phenols and Ethers

- Acidity: Phenols > water > 1° alcohol > 3° alcohol
- Distinction test of alcohols:

Alcohol	Dichromate (Oxidation) test	Victor Meyer's test	Lucas test
1°	Acid (Orange solution becomes green)	Blood red colour	No turbidity
2°	Ketone (Orange solution becomes green)	Blue colour	Turbidity in 5 minutes
3°	No reaction	Colourless	Turbidity immediately

Distinction test of phenol:

Test	Observation
$FeCl_3$ test	Violet colour
$Br_2 - H_2O$ test	White ppt.
Liebermann's nitroso test ($NaNO_2 + \text{conc. } H_2SO_4$)	Deep green/blue colour which changes into red on dilution.
Azo dye test	Orange colour

Aldehydes, Ketones and Carboxylic Acids

- Reactivity order towards S

NCERT CORNER

The questions given in this column have been prepared strictly on the basis of NCERT Chemistry. Last year JEE (Main & Advanced)/ AIPMT/AIIMS/other PMTs have drawn their papers heavily from NCERT books. Practice Hard! All the best!!



1. Ferroelectricity is not exhibited by
 - (a) barium titanate (BaTiO_3)
 - (b) potassium tartrate (Rochelle salt)
 - (c) potassium dihydrogen phosphate (KH_2PO_4)
 - (d) lead zirconate (PbZrO_3).
2. KO_2 (potassium superoxide) is used in oxygen cylinders in space and submarines because it
 - (a) absorbs CO_2 and increases O_2 content
 - (b) produces ozone
 - (c) eliminates moisture
 - (d) absorbs CO_2 .
3. Which of the following complexes will give a pair of enantiomers?
 - (a) $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_6]$
 - (b) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{NO}_2$
 - (c) $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$
 - (d) $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
4. In Fischer-Ringe's method of separation of noble gas mixture from air _____ is used.
 - (a) 90% CaC_2 and 10% CaCl_2
 - (b) coconut charcoal
 - (c) sodalime + potash solution
 - (d) 90% CaCO_3 + 10% urea
5. The higher value of electron affinity for Cl as compared to that of F is due to
 - (a) higher atomic radius of F
 - (b) smaller electronegativity of F
 - (c) weaker electron-electron repulsion in Cl as compared to F
 - (d) more vacant p -subshell in Cl.
6. Which of the following carbonyl compounds is most reactive towards nucleophilic addition reactions ?
 - (a) CCl_3CHO
 - (b) CH_3CHO
 - (c) $\text{C}_2\text{H}_5\text{CHO}$
 - (d) CH_3COCH_3
7. The formula weight of an acid is 82.0. In a titration, 100 mL of the solution of this acid containing 39.0 g of acid per litre were completely neutralised by 95.0 cm^3 of aqueous NaOH containing 40.0 g of NaOH per litre. What is the basicity of the acid?
 - (a) 1
 - (b) 3
 - (c) 0
 - (d) 2
8. Study the reactions carefully.

$$\text{CH}_3\text{CH}_2\text{COOH} \xrightarrow[\text{red P}]{\text{Br}_2} X \xrightarrow[\text{In excess}]{\text{NH}_3 \text{ (alc.)}} Y$$

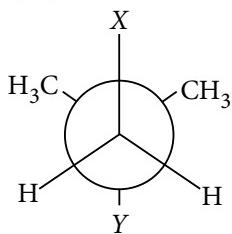
In the above reaction, Y is

 - (a) lactic acid
 - (b) ethylamine
 - (c) propyl amine
 - (d) alanine.
9.

The given polymer is

 - (a) natural rubber
 - (b) gutta percha
 - (c) neoprene
 - (d) polypropylene.
10. Aluminothermy used for the spot welding of large iron structures is based on which fact?
 - (a) Reaction between Fe and oxygen is endothermic.
 - (b) As compared to Al, Fe has greater affinity for oxygen.
 - (c) As compared to Fe, Al has greater affinity for oxygen.
 - (d) Reaction between Al and oxygen is endothermic.
11. A 25 watt bulb emits monochromatic yellow light of wavelength 0.57 μm . Calculate the rate of emission of quanta per second.
 - (a) 7.18×10^{19}
 - (b) 7.18×10^{20}
 - (c) 7.81×10^{19}
 - (d) 7.81×10^{20}

26. In the Newman projection for 2, 2-dimethylbutane



X and Y can respectively be

- (a) H and H (b) H and C₂H₅
 (c) C₂H₅ and H (d) CH₃ and C₂H₅

27. Which of the following converts alcohols to gasoline (petrol)?

- (a) Erionite (b) Gemelinite
 (c) Linde-A (d) ZSM-5

28. In which one of the following reaction is H₂ liberated?

- (a) NaH + H₂O →
 (b) NaCl + H₂O →
 (c) Na₂O + H₂O →
 (d) NaOH + H₂O →

29. If E_a for a certain biological reaction is 50 kJ/mol, by what factor (how many times) will the rate of this reaction increase when body temperature increases from 37°C (normal) to 40°C (fever)?

- (a) 1.15 times (b) 1.20 times
 (c) 2.0 × 10⁵ times (d) 1.0002 times

30. It is not advisable to

- (a) stir copper sulphate solution with a zinc spoon
 (b) stir silver nitrate solution with a copper spoon
 (c) both (a) and (b)
 (d) none of the above.

31. Match the list I with list II and select the correct option.

List I

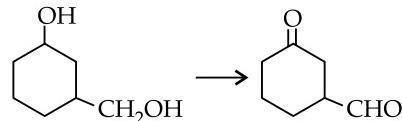
1. Nucleophile
 2. Electrophile
 3. Isomers
 4. Hyperconjugation

List II

- p. Species that can receive a pair of electrons.
 q. Cyclohexane and hex-1-ene
 r. Species that can supply a pair of electrons
 s. Conjugation of electrons of C — H σ-bond with empty p-orbital present at adjacent positively charged carbon.

- (a) 1-p, 2-q, 3-r, 4-s (b) 1-s, 2-p, 3-q, 4-r
 (c) 1-q, 2-p, 3-s, 4-r (d) 1-r, 2-p, 3-q, 4-s

32. The correct reagent for the following oxidation is



- (a) KMnO₄/OH⁻
 (b) K₂Cr₂O₇/H₂SO₄
 (c) pyridinium dichromate
 (d) any of the above.

33. Number of π-bonds in naphthalene is

- (a) 6 (b) 3
 (c) 4 (d) 5

34. Most stable tetrachloride formed by group-16 elements is

- (a) SCl₄ (b) SeCl₄
 (c) TeCl₄ (d) OCl₄

35. Which one of the following is not ore of Mg?

- (a) Dolomite (b) Barytes
 (c) Carnallite (d) Magnesite.

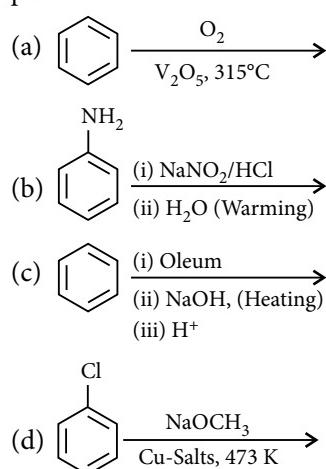
36. The molar solubility (in mol L⁻¹) of a sparingly soluble salt MX₄ is s. The corresponding solubility product is given by K_{sp} . Solubility (s) is given in terms of K_{sp} by the relation

- (a) $s = (K_{sp}/128)^{1/4}$ (b) $(128 K_{sp})^{1/4}$
 (c) $s = (256 K_{sp})^{1/5}$ (d) $(K_{sp}/256)^{1/5}$

37. Which of the following contains highest percentage of carbon monoxide?

- (a) Coal gas (b) Water gas
 (c) Producer gas (d) Bio gas

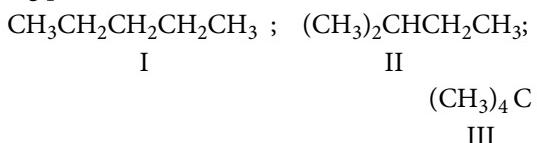
38. Which of the following reactions will not yield phenol?



39. Match the list I with list II.

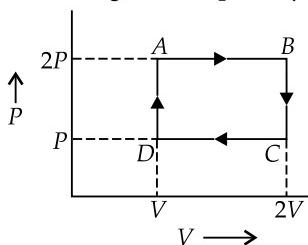
- | List I | List II |
|--|--|
| 1. $RCOOH + N_3H + \text{conc. } H_2SO_4$ | p. Carbylamine reaction |
| 2. Conversion of amide to amine | q. Hofmann's bromamide reaction |
| 3. <i>p</i> -Toluene sulphonyl chloride | r. Schmidt reaction |
| 4. Conversion of primary amine to isocyanide | s. Hinsberg reagent |
| (a) 1-p, 2-q, 3-r, 4-s
(c) 1-r, 2-q, 3-s, 4-p | (b) 1-q, 2-p, 3-s, 4-r
(d) 1-s, 2-p, 3-s, 4-r |

40. Arrange the following in increasing/decreasing boiling point:



- (a) I > II > III (b) II > I > III
(c) III > I > II (d) III < II < I

41. An ideal monoatomic gas follows the path ABCD. The work done during the complete cycle is



- (a) $-PV$ (b) $-2PV$
(c) $-\frac{1}{2}PV$ (d) zero.

42. Thermally, the most stable alkaline earth metal carbonate is

- (a) $MgCO_3$ (b) $CaCO_3$
(c) $SrCO_3$ (d) $BaCO_3$

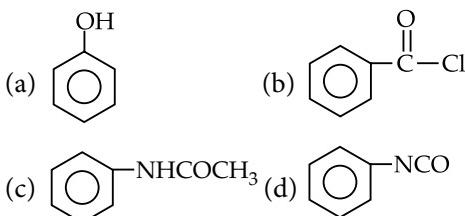
43. Osmotic pressure of urea solution at 10°C is 500 mm. Osmotic pressure of the solution becomes 105.3 mm, when it is diluted and temperature raised to 25°C . The extent of dilution is

- (a) 6 times (b) 5 times
(c) 7 times (d) 4 times.

44. Which of the following statements is correct?

- If BOD of some river water is high,
- it implies that the river is not polluted at all
 - highly polluted with inorganic chemicals
 - highly polluted with organic chemicals which are decomposed by microorganisms
 - polluted with pesticides.

45. What product will form when aniline reacts with phosgene?



46. Given the polymers:

A = Nylon 6, 6; B = Buna-S; C = Polythene. Arrange these in decreasing order of their intermolecular forces.

- $A > B > C$
- $B > C > A$
- $B < C < A$
- $C < A < B$

47. N_2 can be obtained by

- passing NH_3 over red-hot copper (II) oxide
- heating $(NH_4)_2Cr_2O_7$
- passing NH_3 into suspension of bleaching powder
- all of the above.

48. Select the incorrect statement.

- HI is produced by the hydrolysis of PI_3 .
- HF exists as dimer (or oligomer) in vapour phase.
- SCl_6 is octahedral in nature.
- In SO_2X_2 , X can only be F.

49. Which of the following enzymes are used to convert starch into alcohol?

- Maltase, diastase
- Invertase, zymase
- Diastase, maltase, zymase
- Invertase, diastase, zymase

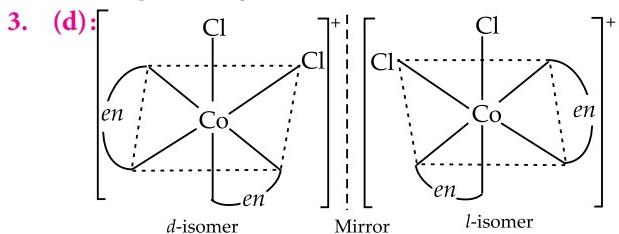
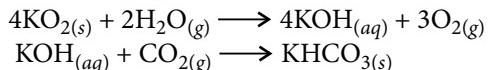
50. Choose the incorrect match.

Catalyst	Function
(a) $PdCl_2$	Wacker's process
(b) Co/Fe	Fischer-Tropsch process
(c) $CuCl_2$	Deacon process
(d) Pt/PtO	Reppe Synthesis

SOLUTIONS

1. (d): Compounds (a), (b) and (c) show ferroelectricity whereas (d) shows anti-ferroelectricity.

2. (a): The moisture of the breath reacts with KO_2 to liberate oxygen and at the same time, KOH formed removes CO_2 exhaled.



4. (a): In Fischer-Ringe's method, air is passed through a mixture of 90% CaC_2 and 10% CaCl_2 heated to 800°C in an iron tube to remove N_2 and O_2 gases.

5. (c)

6. (a): Presence of electron withdrawing substituent makes the carbonyl carbon more electron deficient and hence increases the reactivity towards nucleophilic addition reactions.

7. (d): Let the equivalent weight of the acid be E . Then, normality (N_1) of the acid solution

$$= \frac{39 \text{ g L}^{-1}}{E}$$

Normality (N_2) of NaOH solution

$$= \frac{40 \text{ g L}^{-1}}{40} = 1 \text{ N}$$

On applying, $N_1 V_1 = N_2 V_2$, we have

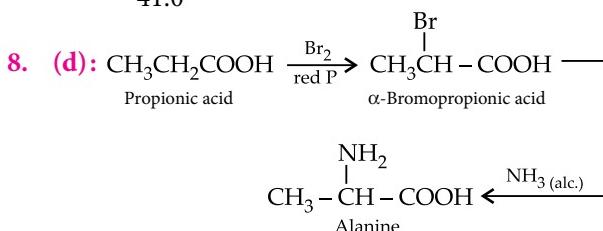
$$\frac{39}{E} \times 100 = 1 \times 95$$

or $E = 41.0$

∴ Basicity of the acid

$$= \frac{\text{Molecular formula weight}}{\text{Equivalent weight}}$$

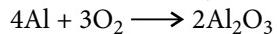
$$= \frac{82.0}{41.0} = 2$$



This reaction is known as Hell-Volhard-Zelinsky reaction.

9. (a): Isoprene (2-methyl-1, 3-butadiene) undergoes *cis*-polymerization to form natural rubber.

10. (c): Al has great affinity for oxygen and reaction between Al and oxygen to form Al_2O_3 is exothermic. Combustion reactions are always exothermic.



11. (a): Energy emitted by the bulb = 25 watt
 $= 25 \text{ J s}^{-1}$ $(\because 1 \text{ watt} = 1 \text{ J s}^{-1})$

Energy of one photon,

$$E = h\nu = h \frac{c}{\lambda}$$

Here, $\lambda = 0.57 \mu\text{m} = 0.57 \times 10^{-6} \text{ m}$
 $(\because 1 \mu\text{m} = 10^{-6} \text{ m})$

$$\therefore E = \frac{(6.62 \times 10^{-34} \text{ J s}) \times (3 \times 10^8 \text{ m s}^{-1})}{0.57 \times 10^{-6} \text{ m}} \\ = 3.48 \times 10^{-19} \text{ J}$$

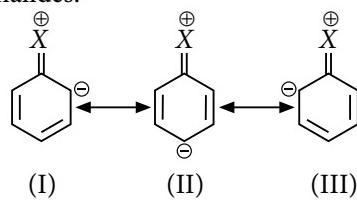
∴ Number of photons emitted per second

$$= \frac{25 \text{ Js}^{-1}}{3.48 \times 10^{-19} \text{ J}} = 7.18 \times 10^{19} \text{ s}^{-1}$$

12. (a): Amongst α , β and γ -hydroxy carbonyl compounds, β -hydroxy is more easily dehydrated than α -hydroxy which is further more easily dehydrated than γ -hydroxy. α and β -hydroxy carbonyl compounds give α, β -unsaturated carbonyl compounds. β -hydroxy carbonyl compound eliminate water molecule by E1cB path.

13. (b): $P : [\text{Ar}] 3d^{10} 4s^1 : \text{Cu}$
 $R : [\text{Ar}] 3d^{10} 4s^2 4p^6 4d^{10} 5s^1 = [\text{Kr}] 4d^{10} 5s^1 : \text{Ag}$

14. (b): The resonating structures I, II and III stabilise the aryl halides.



These structures include a double bond between C and X. The sp^2 hybridized carbon makes the C—X bond shorter and stronger.

15. (b):

Artificial sweetening agent	No. of times sweetener vs Sucrose
Alitame	2000
Aspartame	100
Saccharin	550
Sucratose	600

16. (c) : Metal placed above in electrochemical series replaces the other from its solutions which is lower in the series.

The low E° value containing metals have the high reducing character.

∴ Order of reducing character of three metals is
 $Pb > Cu > Ag$.

17. (c) : $M_{CH_4} = 16 \text{ g/mol}$; Rate_{CH₄} = $1.43 \times 10^{-3} \text{ mol/s}$
 $M_X = ?$; Rate_X = $4.73 \times 10^{-4} \text{ mol/s}$

$$\frac{\text{Rate}_X}{\text{Rate}_{CH_4}} = \frac{\sqrt{M_{CH_4}}}{\sqrt{M_X}}$$

$$\text{Mass of gas } X : \sqrt{M_X} = \frac{\text{Rate}_{CH_4} \sqrt{M_{CH_4}}}{\text{Rate}_X}$$

On substituting the known values

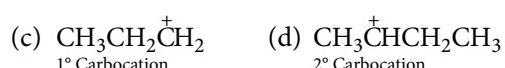
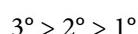
$$\sqrt{M_X} = \frac{1.43 \times 10^{-3} \sqrt{16}}{4.73 \times 10^{-4}}$$

$$\sqrt{M_X} = \frac{1.43 \times 10^{-3} \times 4}{4.73 \times 10^{-4}}$$

$$\sqrt{M_X} = 12.093$$

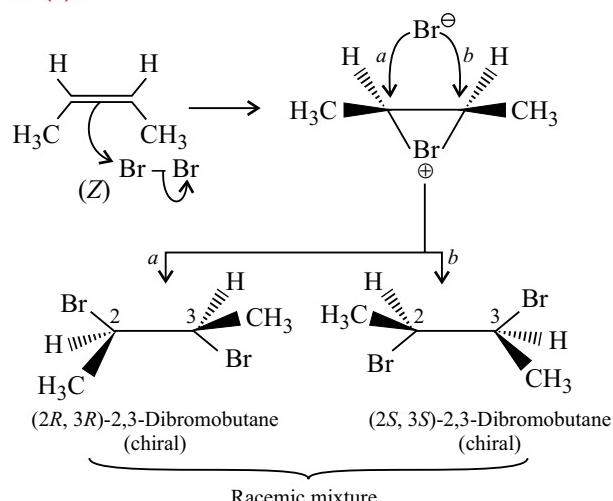
$$M_X = (12.093)^2 = 146.24 \text{ g/mol}$$

18. (b) : The order of stability of carbocation is as follows:



Therefore, $(CH_3)_3\overset{+}{C}$ is the most stable carbocation.

19. (c) :



20. (c) : Like electron, proton also has spin. In case of H₂ molecule, the spins of the two protons can be in the same direction or in the opposite direction. When the spin of the two nuclei (protons) is in the same direction, it is called *ortho*-hydrogen but when spin of the two nuclei (protons) is in the opposite direction, it is called *para*-hydrogen.

21. (d) : **Data-I** **Data-II**

$$t = t_1 \quad t = t_2$$

$$a = 100 \quad a = 100$$

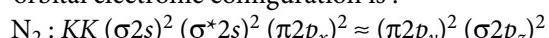
$$x = 90 \quad x = 99.9$$

$$a - x = 10 \quad a - x = 0.1$$

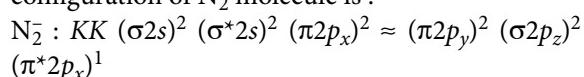
$$k = \frac{2.303}{t_1} \log \left[\frac{100}{10} \right] = \frac{2.303}{t_2} \log \left[\frac{100}{0.1} \right]$$

$$\therefore \frac{1}{t_1} = \frac{3}{t_2} \Rightarrow t_2 = 3t_1$$

22. (a) : N₂ molecule has 14 electrons. Its molecular orbital electronic configuration is :

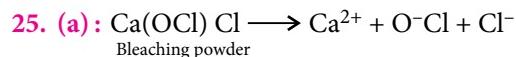
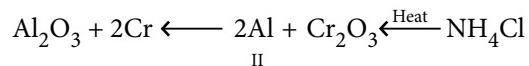
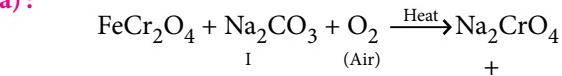


N₂⁻ ion is formed when N₂ accept an electron hence, it has 15 electrons. The molecular orbital electronic configuration of N₂⁻ molecule is :

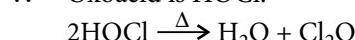


Hence, this electron goes to π -antibonding molecular orbital.

23. (a) :

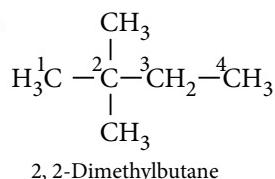


∴ Oxoacid is HOCl.

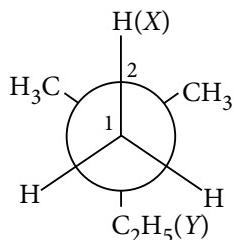


∴ Anhydride of oxoacid, HOCl is Cl₂O.

26. (b) :



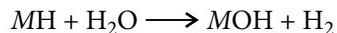
Taking C₁ as the front carbon and looking through C₁-C₂ bond and the Newman's projection would be



Therefore, $X = H$ and $Y = C_2H_5$

27. (d)

28. (a): Alkali metal hydrides react with H_2O to give H_2 .



Due to this property, they are used as reducing agents.

$$\begin{aligned} \text{29. (b): } \log_{10} \frac{k_2}{k_1} &= \frac{-E_a}{2.303R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right) \\ &= -\frac{50 \times 1000}{2.303 \times 8.314} \left(\frac{1}{313} - \frac{1}{310} \right) \end{aligned}$$

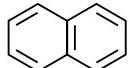
$$\log_{10} \frac{k_2}{k_1} = 0.080 \Rightarrow \frac{k_2}{k_1} = 1.20 \Rightarrow k_2 = 1.20k_1$$

30. (c): In case (a) Cu gets deposited on Zn spoon. In case (b) Ag gets deposited on Cu spoon. So, both of them are not advisable.

31. (d)

32. (c): Pyridinium dichromate (PDC) oxidises 1° alcohols to aldehydes and 2° alcohols to ketones.

33. (d): Naphthalene has 5π-bonds.



34. (c): SCl_4 exists as a monomer (liquid) whereas $SeCl_4$ and $TeCl_4$ exist as tetramers (solids). As the size of the element increases from S to Te, the van der Waals' forces of attraction between the molecules increase and the stability increases. Hence, $TeCl_4$ is most stable. OCl_4 is not formed.

35. (b): Dolomite : $CaCO_3 \cdot MgCO_3$

Barytes : $BaSO_4$

Carnallite : $KMgCl_3 \cdot 6H_2O$

Magnesite : $MgCO_3$

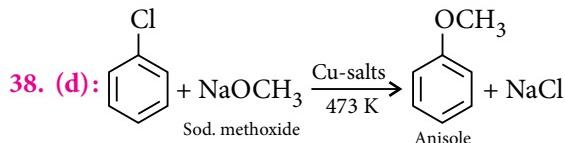
36. (d): Here, $MX_4 \longrightarrow M^{4+} + 4X^-$

$$\therefore K_{sp} = [M^{4+}] [X^-]^4 = s \times (4s)^4 = 256s^5$$

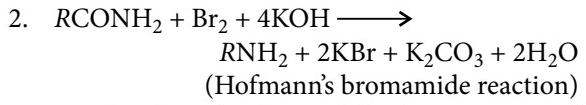
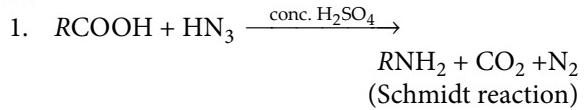
$$\therefore s = \left(\frac{K_{sp}}{256} \right)^{\frac{1}{5}}$$

37. (b):

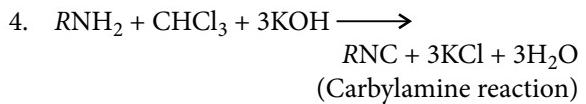
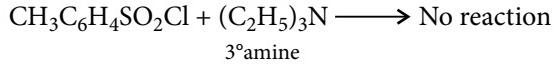
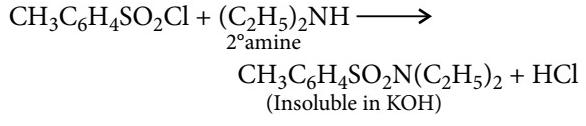
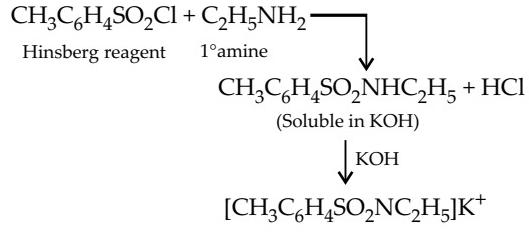
Name of gas	% of CO
Coal gas	10.5%
Water gas	47.75%
Producer gas	30.7%
Bio gas	Trace



39. (c):



3. Hinsberg's method is used for the separation of amine mixtures.



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40. (d)

41. (a): Net work done during the complete cycle is equal to area under the cycle (-ve if cycle is clockwise, i.e., work done by the gas and +ve when cycle is anticlockwise, i.e., work done on the gas).

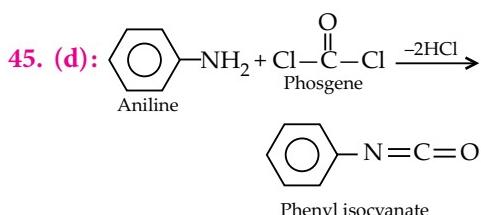
$$w = -P \times V = -(2P - P) \times (2V - V) = -PV$$

42. (d): BaCO_3 is thermally the most stable alkaline earth metal because Ba^{2+} is being the largest in size is more stabilised by larger CO_3^{2-} anion through formation of stable lattice.

$$43. \text{ (b): } \frac{\pi_1}{\pi_2} = \frac{n_1 R T_1 / V_1}{n_2 R T_2 / V_2} \Rightarrow \frac{500}{105.3} = \frac{283 / V_1}{298 / V_2}$$

$$V_2/V_1 = 5$$

44. (c)



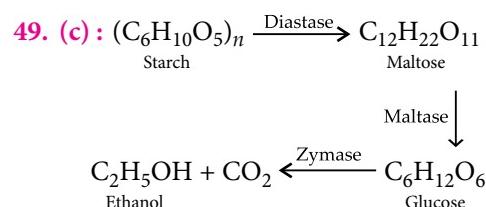
46. (a) : In nylon 6, 6; amide linkage is present. Amide linkage is polar, hence is strongest. Out of buna-S and polythene, buna-S has greater surface area. Hence, it has stronger intermolecular forces.

47. (d): (a) $3\text{CuO} + 2\text{NH}_3 \longrightarrow 3\text{Cu} + \text{N}_2 + 3\text{H}_2\text{O}$

(b) $(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{N}_2 + 4\text{H}_2\text{O} + \text{Cr}_2\text{O}_3$

(c) $3\text{CaOCl}_2 + 2\text{NH}_3 \rightarrow 3\text{CaCl}_2 + 3\text{H}_2\text{O} + \text{N}_2$

48. (c) : SCl_6 does not exist.



50. (d): Pt/PtO is Adams catalyst in reduction.

Ni complexes are used as catalyst in Reppe synthesis (polymerisation of alkynes to give benzene cyclooctatetraene).

◆ ◆

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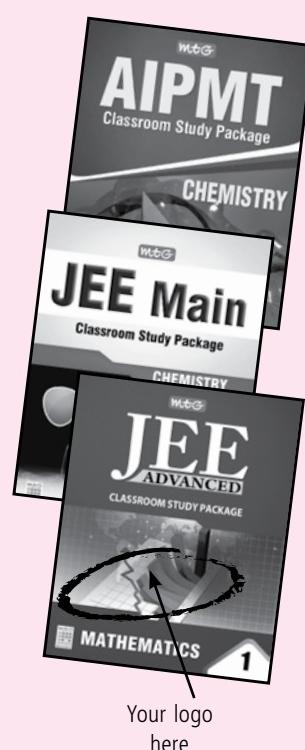
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COMEDK : 10th May
AIIMS : 1st June

1. The number of spherical nodes, angular nodes and nodal planes for $3p_z$ in proper order are
(a) 3, 1, 0 (b) 1, 1, 1
(c) 2, 0, 1 (d) 2, 1, 1
2. Which of the following statements is correct about ferrites?
(a) These possess formula AB_2O_4 (where A is divalent and B is trivalent cation).
(b) These possess spinel structure.
(c) $MgAl_2O_4$ is a ferrite.
(d) All of the above.
3. Which of the following is not an antihistamine?
(a) Chlorpheniramine (b) Chloromycetin
(c) Diphenhydramine (d) Promethazine
4. Which of the following is correct w.r.t. the covalent character?
(a) $NaCl < NaBr < NaI < NaF$
(b) $NaF < NaCl < NaBr < NaI$
(c) $NaI < NaBr < NaCl < NaF$
(d) $NaF < NaBr < NaI < NaCl$
5. Gold number of gelatin is 0.01. The amount of gelatin to be added to 100 mL of standard red gold sol to prevent coagulation by addition of 10 mL of 10% NaCl would be
(a) 0.01 mg (b) 0.001 mg
(c) 0.10 mg (d) 1.00 mg
6. Calculate the number of electrons lost during electrolysis of 2 g Cl^- ions?
(a) 4.69×10^{24} electrons
(b) 3.39×10^{22} electrons
(c) 7.39×10^{22} electrons
(d) 3.59×10^{23} electrons
7. The density of a gas is 1.964 g dm^{-3} at 273 K and 76 cm Hg. The gas is
(a) CH_4 (b) C_2H_6
(c) CO_2 (d) Xe
8. A catalyst lowers the activation energy of the forward reaction by 10 kJ mol^{-1} . What effect does it have on the activation energy of the backward reaction?
(a) Increases by 10 kJ mol^{-1}
(b) Decreases by 10 kJ mol^{-1}
(c) Remains unaffected
(d) Cannot be predicted.
9. About 20 km above the earth there is an ozone layer. Which one of the following statements about ozone and ozone layer is true?
(a) Ozone layer is beneficial to us because ozone cuts out the ultraviolet radiations of the Sun.
(b) The conversion of ozone to oxygen is an endothermic reaction.
(c) Ozone is a triatomic linear molecule.
(d) Ozone layer is harmful to us because it cuts out the radiations useful for photosynthesis.
10. Among the following groups of oxides, the group containing oxides that cannot be reduced by carbon to give the respective metals, is
(a) Cu_2O, SnO_2 (b) Fe_2O_3, ZnO
(c) CaO, K_2O (d) PbO, Fe_3O_4
11. Which of the following will not convert $R - C \equiv N$ to $R - CHO$?
(a) (i) $SnCl_2/HCl$, (ii) H_2O/H^+
(b) (i) $RMgX$, (ii) H_2O/H^+
(c) (i) $AlH(i-Bu)_2$, (ii) H_2O/Δ
(d) All of these will convert $RC \equiv N$ to $RCHO$.

- 12.** Which of the following reactions will give $\text{CH}_2=\text{C}=\text{CH}_2$?
- $\text{CH}_2\text{Br}-\text{CBr}=\text{CH}_2 \xrightarrow{\text{Zn}/\text{CH}_3\text{OH}}$
 - $\text{CH}\equiv\text{C}-\text{CH}_2-\text{COOH} \xrightarrow{\text{K}_2\text{CO}_3(\text{aq.})}$
 - $2\text{CH}_2=\text{CH}-\text{CH}_2\text{I} \xrightarrow{2\text{Na}}$
 - None of these
- 13.** The basic character of TiO , VO and CrO decreases in the order
- $\text{TiO} > \text{VO} > \text{CrO}$
 - $\text{VO} > \text{CrO} > \text{TiO}$
 - $\text{CrO} > \text{VO} > \text{TiO}$
 - $\text{TiO} > \text{CrO} > \text{VO}$
- 14.** Which of the following is used in Clark's method for the removal of temporary hardness?
- Na_2CO_3
 - $\text{Ca}(\text{OH})_2$
 - $\text{Na}_2\text{Al}_2\text{Si}_2\text{O}_8 \cdot x\text{H}_2\text{O}$
 - $\text{Na}_2[\text{Na}_4(\text{PO}_3)_6]$
- 15.** The reactivities of methyl chloride (*A*), propyl chloride (*B*) and chlorobenzene (*C*) are in the order
- $A > B > C$
 - $C > B > A$
 - $A > C > B$
 - $B > A > C$
- 16.**
- B, C and D* respectively are
- aspirin, salol, oil of wintergreen
 - salol, aspirin, oil of wintergreen
 - oil of wintergreen, aspirin, salol
 - oil of wintergreen, salol, aspirin.
- 17.** The state of hybridisation of boron and oxygen atoms in boric acid (H_3BO_3) respectively are
- sp^2, sp^2
 - sp^3, sp^3
 - sp^3, sp^2
 - sp^2, sp^3
- 18.** Which of the following compounds can exhibit optical isomerism?
- (a)
- (b)
- (c)
- (d)
- 19.** Acetamide and ethylamine can be distinguished by reacting with
- aqueous HCl and heat
 - aqueous NaOH and heat
 - acidified NaOH and heat
 - bromine water.
- 20.** In which of the following sets does the oxygen atom has oxidation number in increasing order?
- $\text{Na}_2\text{O} < \text{Na}_2\text{O}_2 < \text{KO}_2 < \text{O}_2(\text{PtF}_6) < \text{OF}_2$
 - $\text{KO}_2 < \text{Na}_2\text{O} < \text{Na}_2\text{O}_2 < \text{O}_2(\text{PtF}_6) < \text{OF}_2$
 - $\text{O}_2(\text{PtF}_6) < \text{KO}_2 < \text{Na}_2\text{O} < \text{Na}_2\text{O}_2 < \text{OF}_2$
 - $\text{OF}_2 < \text{O}_2(\text{PtF}_6) < \text{KO}_2 < \text{Na}_2\text{O} < \text{Na}_2\text{O}_2$
- 21.** Which of the following is a condensation homopolymer?
- Nylon-6
 - Nylon-6,6
 - Nylon-6,10
 - Dacron
- 22.** Which of the following statements is false for alkali metals?
- Lithium is the strongest reducing agent.
 - Oxides of sodium are amphoteric in nature.
 - Li^+ is exceptionally small.
 - All alkali metals give blue solution in liquid ammonia.
- 23.** Which is the correct representation for the solubility product constant of Ag_2CrO_4 ?
- $[\text{Ag}^+]^2[\text{CrO}_4^{2-}]$
 - $[2\text{Ag}^+][\text{CrO}_4^{2-}]$
 - $[\text{Ag}^+][\text{CrO}_4^{2-}]$
 - $[2\text{Ag}^+]^2[\text{CrO}_4^{2-}]$
- 24.** Which of the following are not benzylic alcohols?
- $\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}_2\text{OH}$
 - $\text{C}_6\text{H}_5-\text{CH}_2\text{OH}$
 - $\text{C}_6\text{H}_5-\text{CH}_2-\text{CH}(\text{CH}_3)-\text{OH}$
 - $\text{C}_6\text{H}_5-\text{CH}(\text{CH}_3)-\text{OH}$
- I, II and III
 - I and III
 - II and IV
 - I, III and IV
- 25.** $\frac{1}{4}$ th of Avogadro number of atoms of an element absorb energy 'X' kJ for ionisation. The ionisation energy of the element is
- $\frac{2X}{N_0}$ kJ
 - $\frac{4X}{N_0}$ kJ
 - $\frac{4N_0}{X}$ kJ
 - $\frac{N_0}{X}$ kJ
- 26.** What is the relation of the isoelectric point of an amino acid, to its solubility?
- The two are not related.
 - An amino acid is least soluble at its isoelectric point.

42. Which of the following is not correct about group 18 elements?

- (a) XeO_3 has four σ and four π bonds.
- (b) The hybridisation of Xe in XeF_4 is sp^3d^2 .
- (c) Among the noble gases, the occurrence (percent by weight) of argon is highest in air.
- (d) Liquid helium is used as cryogenic agent.

43. Which of the following solutions cannot act as a buffer?

- (a) $\text{NaH}_2\text{PO}_4 + \text{H}_3\text{PO}_4$
- (b) $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$
- (c) $\text{HCl} + \text{NH}_4\text{OH}$
- (d) B(OH)_3 + borax

44. Copper is heated with dilute and concentrated nitric acid separately. The oxides of nitrogen produced respectively are

- (a) $\text{N}_2\text{O}, \text{NO}_2$
- (b) NO, NO_2
- (c) $\text{NO}_2, \text{N}_2\text{O}_5$
- (d) NO_2, NO

45. For the reaction, $aA \rightarrow xP$, when $[A] = 2.2 \text{ M}$ the rate was found to be 2.4 Ms^{-1} . On reducing concentration of A to half, the rate changes to 0.6 Ms^{-1} . The order of reaction with respect to A is

- (a) 1.5
- (b) 2.0
- (c) 2.5
- (d) 3.0

SOLUTIONS

1. (b): Spherical nodes for $3p_z = n - l - 1 = 3 - 1 - 1 = 1$
Angular nodes for $3p_z = l = 1$
Nodal planes for $3p_z = l = 1$

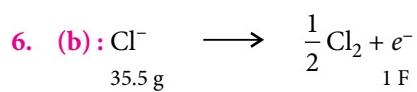
2. (d): Ferrites are the compounds having the general formula, $A\text{Fe}_2\text{O}_4$ ($AB_2\text{O}_4$) where A is a divalent cation. These are obtained by replacing Fe^{2+} ions in Fe_3O_4 by divalent cations. In these compounds, divalent cations occupy tetrahedral voids whereas trivalent cations occupy octahedral voids. Fe_3O_4 is an inverse spinel having formula $\text{Fe}^{\text{II}}\text{Fe}^{\text{III}}_2\text{O}_4$. MgAl_2O_4 is a ferrite with a spinel structure where Mg^{2+} ions occupy tetrahedral holes and Al^{3+} ions occupy octahedral holes.

3. (b): Chloromycetin is an antibiotic.

4. (b): For the same cation, larger the size of anion, larger is the polarisability and higher is the covalent character.

5. (c) : 10 mL gold sol requires gelatin = 0.01 mg
100 mL gold sol requires gelatin

$$= \frac{0.01 \times 100}{10} = 0.1 \text{ mg}$$



$$(6.023 \times 10^{23} \text{ electrons})$$

35.5 g of Cl^- ions loses = 6.023×10^{23} electrons

$$2 \text{ g of } \text{Cl}^- \text{ ions will lose} = \frac{6.023 \times 10^{23}}{35.5} \times 2$$

$$= 3.39 \times 10^{22} \text{ electrons}$$



$$M = \frac{1.964 \times 0.082 \times 273}{1} = 43.97 \approx 44$$

[$\because 76 \text{ cm Hg} = 1 \text{ atm}$]

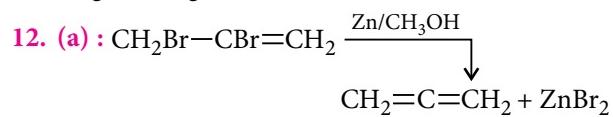
The gas is CO_2 .

8. (b): Catalyst brings the equilibrium faster by decreasing the activation energy for both forward and backward reactions.

9. (a)

10. (c) : CaO and K_2O are oxides of Ca and K, which are stronger reducing agents than carbon.

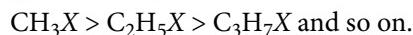
11. (b) : RMgX , $\text{H}_2\text{O}/\text{H}^+$ will produce ketone which may further change to 3° alcohol, if Grignard reagent RMgX is taken in excess.



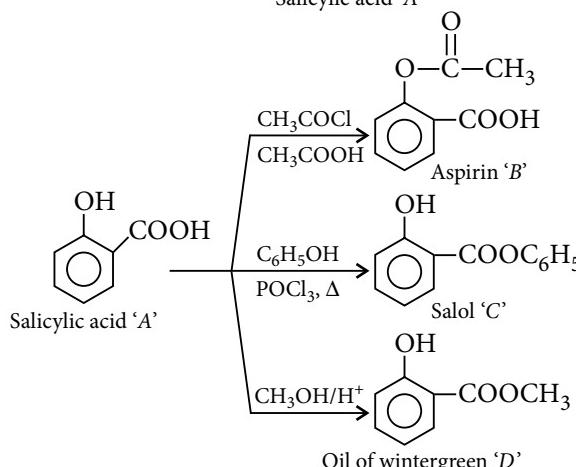
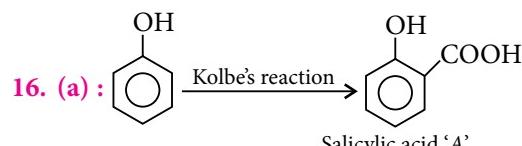
13. (a)

14. (b)

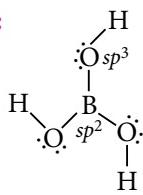
15. (a) : Among the primary alkyl halides, reactivity follows the order :



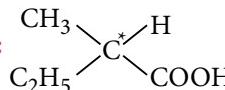
Chlorobenzene is less reactive due to resonance.



17. (d) :



18. (b) :



It has asymmetric chiral C-atom hence, exhibits optical isomerism.

19. (b) : $\text{CH}_3\text{CONH}_2 + \text{NaOH}_{(aq)} \xrightarrow{\Delta} \text{CH}_3\text{COONa} + \text{NH}_3 \uparrow$
 $\text{CH}_3\text{CH}_2\text{NH}_2 + \text{NaOH}_{(aq)} \xrightarrow{\Delta} \text{No reaction}$

20. (a) : $\text{Na}_2\overset{-2}{\text{O}}, \text{Na}_2\overset{-1}{\text{O}}_2, \text{KO}_2, \overset{-1/2}{\text{O}_2}(\text{PtF}_6), \overset{+2}{\text{OF}_2}$

21. (a) : Nylon-6 is a condensation homopolymer of caprolactam.

22. (b) : Oxides of sodium are basic in nature.

23. (a) : $\text{Ag}_2\text{CrO}_4 \rightleftharpoons 2\text{Ag}^+ + \text{CrO}_4^{2-}$

$$K_{sp} = [\text{Ag}^+]^2[\text{CrO}_4^{2-}]$$

24. (b) : Alcohols I and III are not benzylic alcohols since they do not carry the $-\text{OH}$ group on that carbon which is directly linked to the benzene ring.

25. (b) : $\frac{1}{4} N_0$ (i.e., $\frac{1}{4}$ mol) atoms require energy = X kJ

1 N_0 (i.e., 1 mol) atoms require energy = $4X$ kJ

$$1 \text{ atom requires energy} = \frac{4X}{N_0} \text{ kJ}$$

26. (b) : An amino acid is least soluble at its isoelectric point, since it exists as zwitter ion at isoelectric point.

27. (d) : $A + 3B \rightleftharpoons 2C$

1 mol of A reacts with 3 mol of B .

5 mol of A will react with 15 mol of B .

Given moles of B are 12 hence, B is a limiting reagent.

Now, 3 mol of B will give 2 mol of C .

So, 12 mol of B will give $\frac{2 \times 12}{3}$, i.e., 8 mol of C .

28. (a) : Common glass : $\text{Na}_2\text{O} \cdot \text{CaO} \cdot 6\text{SiO}_2$

29. (c) : $\text{Ag}_2\text{O} + \text{H}_2\overset{-1}{\text{O}_2} \rightarrow 2\text{Ag} + \text{H}_2\overset{-2}{\text{O}} + \overset{0}{\text{O}_2}$

H_2O_2 is oxidised to O_2 thus, acts as reducing agent.

30. (d) : For isothermal reversible expansion,

$$w = -2.303nRT \log \frac{P_1}{P_2}$$

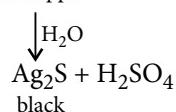
As all factors same,

$$w \propto \frac{1}{\text{Molecular weight}}$$

NO and C_2H_6 both have equal molecular weights 30 g mol^{-1} hence, will produce equal work.

31. (a) : $2\text{MnO}_2 + 4\text{KOH} + \text{O}_2 \longrightarrow 2\text{K}_2\text{MnO}_4 + 2\text{H}_2\text{O}$ green

32. (d) : (i) $\text{Na}_2\text{S}_2\text{O}_3 + 2\text{HCl}_{(\text{dil.})} \longrightarrow 2\text{NaCl} + \text{SO}_2 + \text{H}_2\text{O} + \text{S}$
(ii) $\text{KI}_3 + 2\text{Na}_2\text{S}_2\text{O}_3 \longrightarrow \text{KI} + 2\text{NaI} + \text{Na}_2\text{S}_4\text{O}_6$
(iii) $2\text{AgNO}_3 + \text{Na}_2\text{S}_2\text{O}_3 \longrightarrow \text{Ag}_2\text{S}_2\text{O}_3 + 2\text{NaNO}_3$
white ppt.



33. (d) : Ionisation of different amino acids takes place at a specific pH value.

34. (d) : According to van der Waals' equation,

$$\left(P + \frac{a}{V^2} \right) (V - b) = RT$$

At very low pressure, volume (V) is very large. Hence, a/V^2 is so small that it can be neglected. Similarly, volume correction term ' b ' can also be neglected in comparison to V . Thus, the above equation reduces to $PV = RT$. Hence, at very low pressure a real gas behaves like an ideal gas.

$$\therefore Z = \frac{PV}{RT} = 1$$

35. (d) : $2\text{Ca}(\text{OH})_2 + 2\text{Cl}_2 \longrightarrow \underbrace{\text{CaCl}_2 + \text{Ca}(\text{OCl})_2}_{\substack{\text{Slaked lime} \\ \text{Bleaching powder}}} + 2\text{H}_2\text{O}$

36. (c) : Enthalpy of formation of 9 g of water = -142.5 kJ
Enthalpy of formation of water per mole (i.e., 18 g)

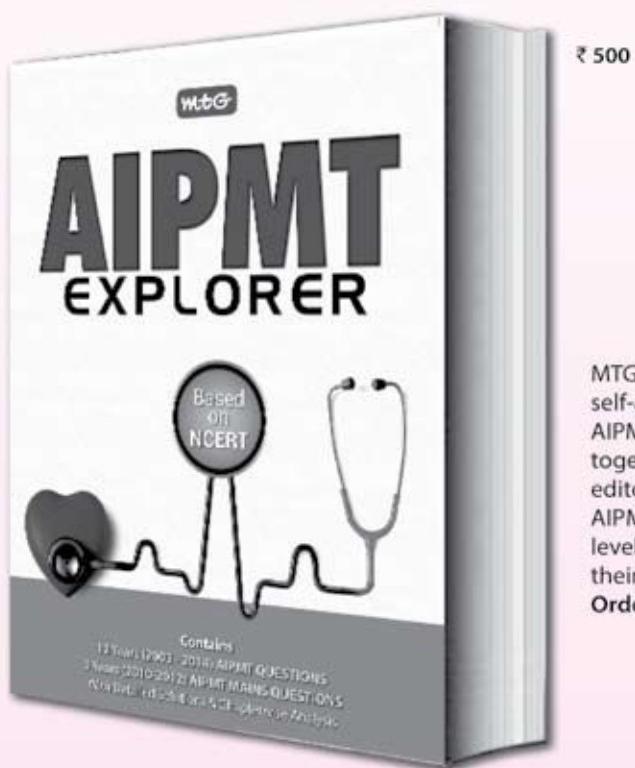
$$= \frac{-142.5 \times 18}{9} = -285 \text{ kJ mol}^{-1}$$



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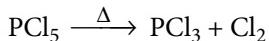
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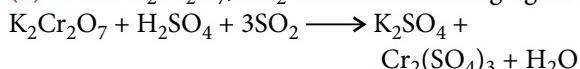
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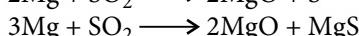
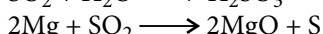
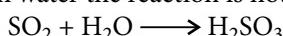
37. (b) : PCl_5 is reactive because in its geometry two axial bonds are relatively longer and weaker than three equatorial bonds thus, PCl_5 readily decomposes to PCl_3 .



38. (b) : With $\text{K}_2\text{Cr}_2\text{O}_7$, SO_2 works as reducing agent.



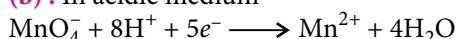
With water the reaction is not a redox reaction,



39. (b) : Both Fe^{3+} and Mn^{2+} have same number of electrons i.e. 23. Hence both have same electronic configuration ($3d^5$).

40. (d) : None of the compounds have α -hydrogen. Hence, all of the given compounds would not give Hell-Volhard-Zelinsky reaction.

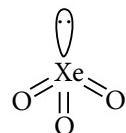
41. (b) : In acidic medium



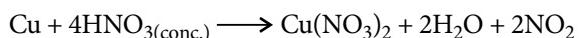
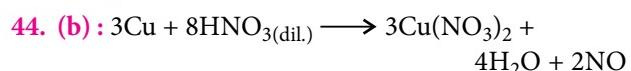
Thus, eq. wt. of $\text{KMnO}_4 = \frac{\text{Mol. wt.}}{5} = \frac{158}{5} = 31.6$ g

$\therefore 1\text{ N solution can be prepared by dissolving } 31.6\text{ g of } \text{KMnO}_4 \text{ in } 1\text{L solution.}$

42. (a) : XeO_3 has 3 σ and 3 π bonds.



43. (c) : A solution of strong acid (HCl) and weak base (NH_4OH) cannot act as a buffer.



44. (b) : Rate = $k [A]^n$

$$r_1 = 2.4 = k [A]^n \quad \dots(\text{i})$$

$$r_2 = 0.6 = k \left[\frac{1}{2} A \right]^n \quad \dots(\text{ii})$$

On solving equations (i) and (ii), we get

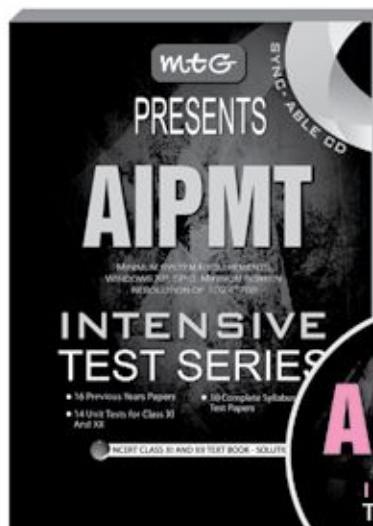
$$\frac{2.4}{0.6} = (2)^n$$

$$4 = (2)^n$$

$\therefore n = 2$, i.e., second order reaction.



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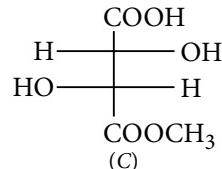
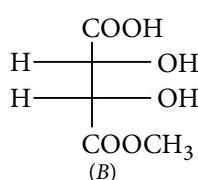
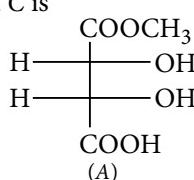
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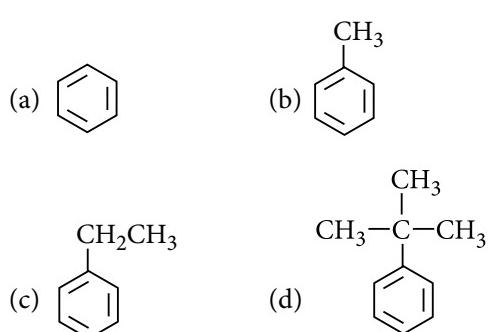


- Which of the following is water soluble?
(a) $[\text{Ni}(\text{CO})_4]$ (b) $[\text{Ni}(\text{DMG})_2]$
(c) $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ (d) $[\text{Pt}(\text{NH}_3)_4]\text{Cl}_2$
- Which of the following is not the characteristic property of alcohols?
(a) Lower members have pleasant smell, higher members are odourless, tasteless.
(b) Lower members are insoluble in water, but it regularly increases with increase in molecular weight.
(c) Boiling point rises regularly with the increase in molecular weight.
(d) Alcohols are lighter than water.
- The estimation of reducing substances by the use of standard iodine solution is called
(a) iodimetry (b) iodometry
(c) both (a) and (b) (d) none of these.
- How many stereoisomers may exist for the compound pentane-2,3-diol?
(a) 0 (b) 2
(c) 3 (d) 4
- Phenol and cyclohexanol can be chemically distinguished by all the given reagents except
(a) $\text{Br}_2/\text{H}_2\text{O}$
(b) anhydrous $\text{ZnCl}_2/\text{conc. HCl}$
(c) neutral FeCl_3
(d) metallic sodium.
- The correct statement about the compounds A, B and C is



- (a) A and B are identical
(b) A and B are diastereomers
(c) A and C are enantiomers
(d) A and B are enantiomers.
- Which of these ions has the greatest tendency to form complex ions?
(a) K^+ (b) Hg^{2+}
(c) Co^{3+} (d) Zn^{2+}
- Which of the following reactions may not yield an amine as one of the products?
(a) $\text{R}-\text{NO}_2 \xrightarrow[\text{HCl}]{\text{Sn}} \text{R}-\text{NH}_2$ (b) $\text{R}-\text{CONH}_2 \xrightarrow[\text{KOH}]{\text{Br}_2} \text{R}-\text{NH}_2$
(c) $\text{R}-\text{CN} \xrightarrow{\text{LiAlH}_4} \text{R}-\text{NH}_2$ (d) $\text{RCOOH} \xrightarrow[\text{heat}]{\text{NH}_3} \text{R}-\text{NH}_2$
- Which of the following mixtures will give a buffer solution when dissolved in 500.00 mL of water?
(a) 0.200 mol of aniline and 0.200 mol of HCl
(b) 0.200 mol of aniline and 0.400 mol of NaOH
(c) 0.200 mol of NaCl and 0.100 mol of HCl
(d) 0.200 mol of aniline and 0.100 mol of HCl
- Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3 \text{ m s}^{-1}$.
(Mass of proton = $1.67 \times 10^{-27} \text{ kg}$ and
 $h = 6.63 \times 10^{-34} \text{ J s}$)
(a) 0.40 nm (b) 2.5 nm
(c) 14.0 nm (d) 0.032 nm

- 25.** Which of the following statements is true?
- Allyl chloride is more reactive than vinyl chloride.
 - Vinyl chloride is as reactive as allyl chloride.
 - Vinyl chloride is more reactive than allyl chloride.
 - Both of them are more reactive than chlorobenzene.
- 26.** In the reaction,
- $$\text{HCHO} + \text{CH}_3\text{MgI} \rightarrow A \xrightarrow{\text{H}_2\text{O}} B + \text{Mg(OH)I}$$
- A and B are respectively
- CH_3OMgI and $\text{CH}_3 - \text{OH}$
 - $\text{CH}_3\text{CH}_2\text{OMgI}$ and $\text{C}_2\text{H}_5 - \text{O} - \text{C}_2\text{H}_5$
 - $\text{CH}_3\text{CH}_2\text{OMgI}$ and $\text{CH}_3 - \text{CH}_2 - \text{OH}$
 - $\text{CH}_3 - \text{CH}_2 - \text{I}$ and $\text{CH}_3 - \text{CH}_2 - \text{OH}$
- 27.** In the balanced equation :
- $$\text{H}_2\text{SO}_4 + x\text{HI} \rightarrow \text{H}_2\text{S} + y\text{I}_2 + z\text{H}_2\text{O}$$
- the values of x, y and z are
- 3, 5, 2
 - 4, 8, 5
 - 8, 4, 4
 - 5, 3, 4
- 28.** Principal, azimuthal and magnetic quantum numbers are respectively related to
- shape, size and orientation
 - size, shape and orientation
 - size, orientation and shape
 - none of these.
- 29.** ${}_1^1\text{H} + {}_1^3\text{H} \rightarrow {}_2^4\text{He}$ represents
- β -decay
 - fusion
 - fission
 - α -decay.
- 30.** Which of the following statements is correct about halogens?
- They are all diatomic and form univalent ions.
 - They are all capable of exhibiting several oxidation states.
 - They are all diatomic and form divalent ions.
 - They can mutually displace each other from the solution of their compounds with metals.
- 31.** The percentage composition of an organic compound containing C, H and O is C = 40% and H = 6.67 %. If the vapour density of the compound is 60, its molecular formula will be
- $\text{C}_4\text{H}_8\text{O}_4$
 - $\text{C}_7\text{H}_6\text{O}_2$
 - $\text{C}_2\text{H}_2\text{O}_4$
 - $\text{C}_3\text{H}_6\text{O}_2$
- 32.** Under which of the following conditions, work is a state function?
- Adiabatic process
 - Isothermal process
 - Constant pressure
 - None of these
- 33.** In which of the following molecules, S atom does not assume sp^3 hybridisation?
- SO_4^{2-}
 - SF_4
 - SF_2
 - S_8
- 34.** How many hydrate isomers are possible with formula $\text{CrCl}_3 \cdot 6\text{H}_2\text{O}$?
- 4
 - 3
 - 2
 - 5
- 35.** Arsenic sulphide sol is prepared by passing H_2S through arsenic oxide solution. The charge developed on the particles is due to adsorption of
- H^+
 - S^{2-}
 - OH^-
 - O^{2-}
- 36.** $\text{CH}_3 - \begin{array}{c} \text{CH}_3 \\ | \\ \text{C} - \text{CH} = \text{CH}_2 \\ | \\ \text{CH}_3 \end{array} \xrightarrow[\text{H}_2\text{O}_2, \text{OH}^-]{\text{B}_2\text{H}_6, \text{THF}} (\text{A})$
- The product (A) is
- $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH} - \text{CH}_3 \\ | \\ \text{CH}_3 \quad \text{OH} \end{array}$
 - $\begin{array}{c} \text{OH} \\ | \\ \text{CH}_3 - \text{C} - \text{CH} - \text{CH}_3 \\ | \\ \text{CH}_3 \quad \text{CH}_3 \end{array}$
 - $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3 - \text{C} - \text{CH}_2 - \text{CH}_2\text{OH} \\ | \\ \text{CH}_3 \end{array}$
 - $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_2 - \text{C} - \text{CH}_2 - \text{CH}_3 \\ | \\ \text{OH} \quad \text{CH}_3 \end{array}$
- 37.** Which one of the following statements is not true?
- For first order reaction, straight line graph of $\log(a - x)$ versus t is obtained for which slope = $-k/2.303$.
 - A plot of $\log k$ vs $1/T$ gives a straight line graph for which slope = $-E_a/2.303R$.
 - For third order reaction, the product of $t_{1/2}$ and initial concentration a is constant.
 - Units of k for the first order reaction are independent of concentration units.
- 38.** Which of the following aromatic compounds undergoes nitration fastest?

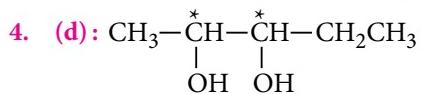


40. If K_1 and K_2 are the ionization constants of $\text{H}_3\overset{+}{\text{N}}\text{CHRCOOH}$ and $\text{H}_3\overset{+}{\text{N}}\text{CHRCOO}^-$ respectively, the pH of the solution at the isoelectric point is

- $\text{pH} = \text{p}K_1 + \text{p}K_2$
- $\text{pH} = (\text{p}K_1 \text{ p}K_2)^{1/2}$
- $\text{pH} = (\text{p}K_1 + \text{p}K_2)^{1/2}$
- $\text{pH} = (\text{p}K_1 + \text{p}K_2)/2$.

SOLUTIONS

1. **(d)**: $[\text{Ni}(\text{CO})_4]$, $[\text{Ni}(\text{DMG})_2]$ and $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ are non-ionisable covalent compounds. $[\text{Pt}(\text{NH}_3)_4]\text{Cl}_2$ is ionisable to $[\text{Pt}(\text{NH}_3)_4]^{2+}$ and 2Cl^- therefore ionic and water soluble.
 2. **(b)**: Lower members, only, are soluble in water.
 3. **(a)**: When an analyte which is a reducing agent is titrated directly with a standard iodine solution, the method is called “iodometry”. When an analyte that is an oxidising agent is added to excess iodide to produce iodine and the iodine produced is determined by titration with sodium thiosulphate, the method is called “iodometry”.



Number of chiral carbons = 2

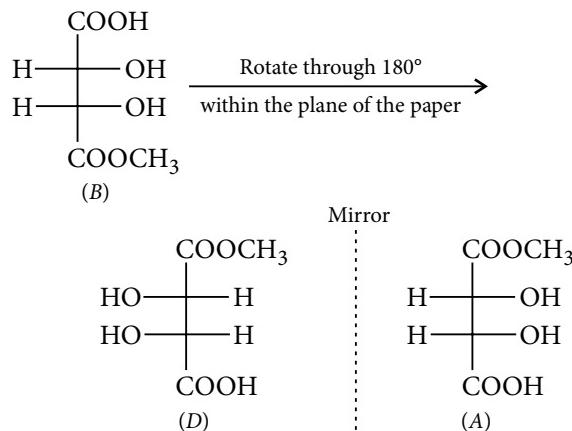
Number of planes of symmetry = nil

$$\therefore \text{Total isomers} = 2^2 = 4$$

5. (d):  and 

Both will liberate H₂ gas with Na metal.

6. (d): Rotation of (B) through 180° within the plane of the paper gives (D) which is an enantiomer of (A).



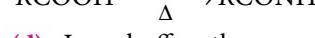
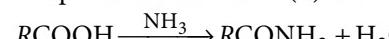
Thus, A and B are enantiomers.

7. **(c)**: Because of smaller size and higher charge Co^{3+} has greatest tendency to form complexes.

8. **(d)**: $\text{RCN} \xrightarrow[\text{[H]}]{\text{LiAlH}_4} \text{RCH}_2\text{NH}_2$

$\xrightarrow{\text{Sn/HCl}}$

The product obtained in (d) is an amide.

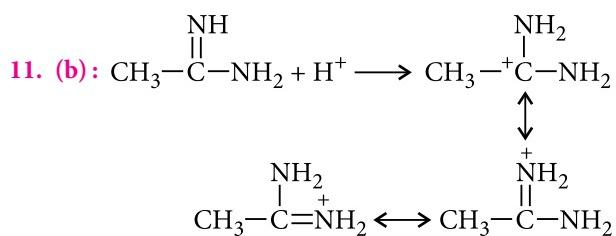


(d): In a buffer, there are (i) weak acid and conjugate base or (ii) weak base and its conjugate acid

In (d), 0.100 mol of HCl will convert 0.100 mol of aniline into anilinium ion, mixture will contain 0.100 mol of aniline and 0.100 mol of anilinium salt. Hence it is a buffer.

- 10. (a) :** According to de Broglie equation,

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34}}{1.67 \times 10^{-27} \times 1.0 \times 10^3} = 4 \times 10^{-10} \text{ m} = 0.40 \text{ nm}$$



The conjugate acid obtained by addition of a proton to (I) is stabilized by two equivalent resonance structures and hence compound (I) is the most basic. Further 2° amines are more basic than 1° amines while amides are least basic due to delocalization of lone pair of electrons of N over the CO group. Thus the order is I > III > II > IV.

12. (c) : $P = 0.658 \text{ atm}$, $T = 373 \text{ K}$, $w = 0.553 \text{ g}$

$$V = \frac{407}{1000} \text{ L}$$

$$M = \frac{wRT}{PV} = \frac{0.553 \times 0.0821 \times 373}{0.658 \times 407 / 1000} = 63.23$$

$\therefore 100 \text{ g compound has B} = 85.7 \text{ g}$

$$\therefore 63.23 \text{ g compound has B} = \frac{85.7 \times 63.23}{100} = 54.2$$

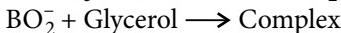
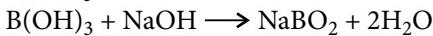
$$\frac{54.2}{10.8} \text{ g atom of B} = 5 \text{ g atom of B}$$

Formula is B_5H_x

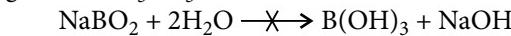
$$\therefore 5 \times 10.8 + x = 63.23 \text{ or } x = 9.23 \approx 9$$

\therefore Mol. formula of the compound is B_5H_9 .

13. (b) : Polyhydroxy compounds such as glycerol, mannitol, catechol, etc. form a stable complex with BO_2^- formed due to the reaction of NaOH and $B(OH)_3$.



Due to this, BO_2^- does not undergo hydrolysis to give back H_3BO_3 and NaOH.



and hence boric acid can be titrated against NaOH as it behaves as a strong monobasic acid.

14. (d) : $A + 2B \rightleftharpoons C + D$;

x = mol of A remaining at equilibrium

Moles of A reacted = $1 - x$;

Moles of B reacted = $2(1 - x)$

Moles of B remaining = $3 - 2(1 - x) = 1 + 2x \approx 1$

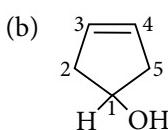
($\because K$ is very large, $x \ll 1$)

Moles of C = Moles of D = $1 - x \approx 1$

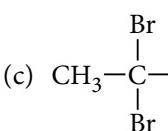
$$\text{Hence, } K = 1.0 \times 10^8 = \frac{[C][D]}{[A][B]^2} = \frac{1 \times 1}{x \times (1)^2} = \frac{1}{x}$$

$$\Rightarrow x = 1.0 \times 10^{-8} \text{ mol L}^{-1}$$

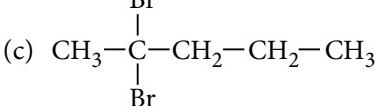
15. (a) : (a)  Hydroxyl bearing carbon is stereogenic centre.



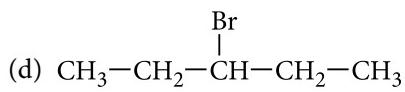
As C-2 resembles C-5 and C-3 resembles C-4, so it has no stereogenic centre.



It has no stereogenic centre.



It has no stereogenic centre.



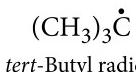
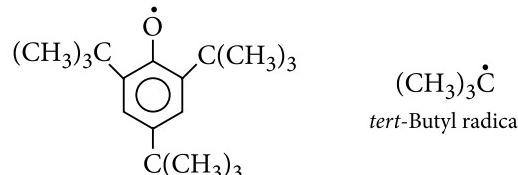
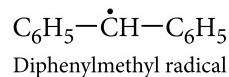
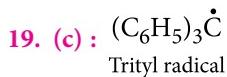
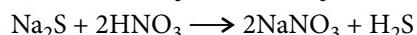
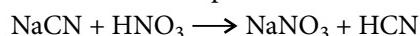
It has no stereogenic centre.

16. (c) : In NO_3^- , N-atom is sp^2 hybridized as $(sp^2)^2(sp^2)^1(sp^2)^12p_z^1$.

Completely filled sp^2 hybrid orbital on N-atom donates an electron pair to the vacant $2p$ orbital of O-atom to form dative bond. Other two hybrid orbitals form (N—O) σ -bonds. The pure $2p_z^1$ orbital forms (N—O) π -bond.

17. (c) : Dacron (terylene) is a polymer of ethylene glycol and terephthalic acid.

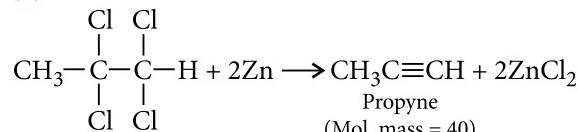
18. (d) : In case N and S are present along with the halogens in the organic compound the Lassaigne's extract will also contain Na_2S and NaCN along with the sodium halide which will interfere with the test. Nitric acid decomposes NaCN and Na_2S .



2,4,6-Tri-tert-butylphenoxy radical

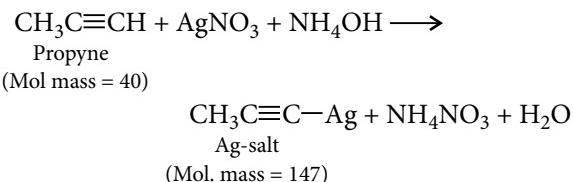
Besides resonance/inductive effects, the stability of free radicals depends upon steric hindrance which prevents their tendency to form dimers. All the radicals listed above are stabilized either by resonance/inductive effects but 2,4,6-tri-tert-butyl phenoxy radical is also stabilized by steric hindrance which does not allow it to dimerize, therefore, it is the most stable free radical.

20. (b) :



1,1,2,2-Tetrachloropropane
(Mol. mass = 182)

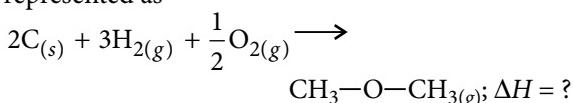
Mass of propyne obtained from 36.4 g of 1,1,2,2-tetrachloropropane = $\frac{40}{182} \times 36.4 = 8 \text{ g}$



Mass of precipitate obtained from 8 g of propyne

$$= \frac{147}{40} \times 8 = 29.4 \text{ g}$$

- 21. (a) :** The formation of CH_3OCH_3 may be represented as



It involves vaporisation of 2 gram atoms of solid carbon and breaking of 3 moles of H – H bonds and $\frac{1}{2}$ mole of O=O bond resulting in the formation of 6 C–H bonds and 2 C–O bonds. Thus, the heat of formation of $\text{CH}_3-\text{O}-\text{CH}_3$ is given by

$$\Delta H = (2 \times 125 + 3 \times 103 + \frac{1}{2} \times 177) - (6 \times 87 + 2 \times 70)$$

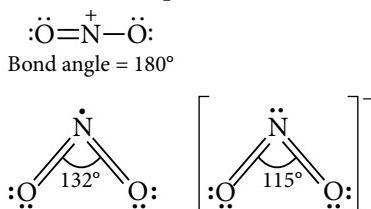
$$= -14.5 \text{ kcal}$$

- 22. (d) :** $\Delta G^\circ = -RT \ln K_p$

$$\ln K_p = \frac{-\Delta G^\circ}{RT}$$

$$\Rightarrow K_p = e^{-\Delta G^\circ/RT}$$

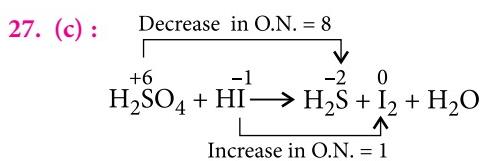
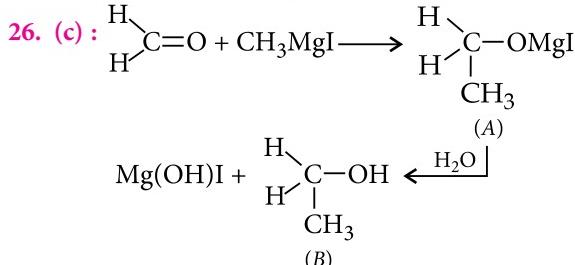
- 23. (c) :** The bond angles of NO_2 , NO_2^+ and NO_2^- are in the order $\text{NO}_2^+ > \text{NO}_2 > \text{NO}_2^-$. This is because NO_2^+ has no unshared electron and hence it is linear. NO_2 has one unshared electron while NO_2^- has one unshared electron pair.



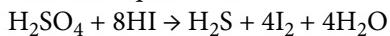
- 24. (b) :** Due to intramolecular hydrogen bonding in *ortho*-isomer, it has least melting point. Due to effective intermolecular hydrogen bonding and symmetrical structure in *para*-isomer, it has highest melting point among the isomers. Therefore, the order is

para-isomer > *meta*-isomer > *ortho*-isomer.
(114°C) (97°C) (45°C)

- 25. (a) :** Allyl carbocation is more stable than vinyl carbocation as allyl carbocation possesses greater number of resonating structures.



Balanced equation is



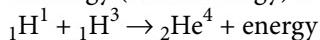
$$x = 8, y = 4, z = 4$$

- 28. (b) :** Principal quantum number (n) represents the size and energy of the shell of the electron.

Azimuthal quantum number (l) describes the spatial distribution of electron cloud and angular momentum.

Magnetic quantum number (m) describes the possible orientations of orbitals.

- 29. (b) :** Nuclear fusion is a nuclear reaction in which lighter nuclei combine together to form a single, heavy and more stable nucleus and a large amount of energy (fusion energy) is released.



- 30. (a) :** All halogens are diatomic and form univalent ions.

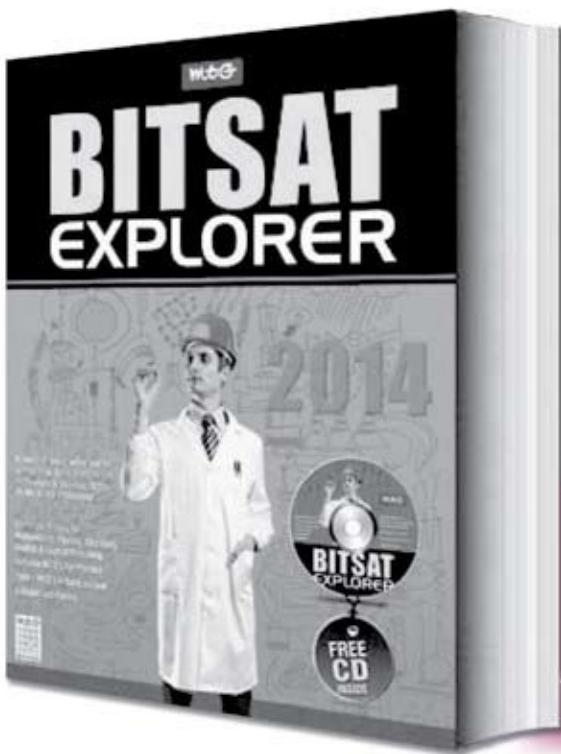
- 31. (a) :**

Element	% of element	At. mass of element	Relative no. of moles	Simplest molar ratio
C	40%	12	$\frac{40}{12} = 3.33$	1
H	6.67%	1	$\frac{6.67}{1} = 6.67$	2
O	53.33%	16	$\frac{53.33}{16} = 3.33$	1

Empirical formula = CH_2O

Empirical formula mass = $(12 + 2 + 16) = 30$

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Vapour density of the compound = 60

$$\text{Molecular mass} = 2 \times \text{Vapour density} \\ = 2 \times 60 = 120$$

$$n = \frac{\text{Mol. mass}}{\text{Emp. mass}} = \frac{120}{30} = 4$$

$$\text{Molecular formula} = n \times (\text{Empirical formula}) \\ = 4 \times (\text{CH}_2\text{O}) = \text{C}_4\text{H}_8\text{O}_4$$

- 32. (a) :** In an adiabatic process, $q = 0$. Hence $\Delta E = q + w$ gives $\Delta E = w$. As ΔE is a state function, hence w becomes a state function.

33. (b) : $H = \frac{1}{2} [V + M - C + A]$

where, H = number of orbitals involved in hybridization

V = valence electrons of central atom

M = number of monovalent atoms linked with central atom

C = charge on the cation

A = charge on the anion

$$\text{SO}_4^{2-}, H = \frac{1}{2} [6 + 0 - 0 + 2] = 4, \text{sp}^3 \text{ hybridisation}$$

$$\text{SF}_4, H = \frac{1}{2} [6 + 4 - 0 + 0] = 5, \text{sp}^3d \text{ hybridisation}$$

$$\text{SF}_2, H = \frac{1}{2} [6 + 2 - 0 + 0] = 4, \text{sp}^3 \text{ hybridisation}$$

The hybridisation of S in S_8 is sp^3 .

34. (b) : $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}; [\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl} \cdot 2\text{H}_2\text{O}; [\text{Cr}(\text{H}_2\text{O})_3\text{Cl}_3] \cdot 3\text{H}_2\text{O}$

35. (b) : $\text{As}_2\text{O}_{3(aq)} + 3\text{H}_2\text{S}_{(aq)} \rightarrow \text{As}_2\text{S}_3 + 3\text{H}_2\text{O}$
Colloidal sol

As_2S_3 then adsorbs S^{2-} ions from H_2S solution containing H^+ and S^{2-} ions and becomes negatively charged.

- 36. (c) :** It is a hydroboration-oxidation reaction. It is the addition of H_2O according to anti-Markownikoff's rule. Hence, terminal carbon gets the $- \text{OH}$ group.

37. (c) : $\log k = -\frac{E_a}{2.303RT} + \log A$ (straight line)

$$\text{Slope} = -\frac{E_a}{2.303R}$$

First order reaction,

$$k = \frac{2.303}{t} \log \frac{C}{C-x} \text{ (straight line)}$$

$$\text{Slope} = -\frac{k}{2.303}$$

$$t_{1/2} \propto a^{1-n}; \quad n = 3, \quad t_{1/2} \propto \frac{1}{a^2}$$

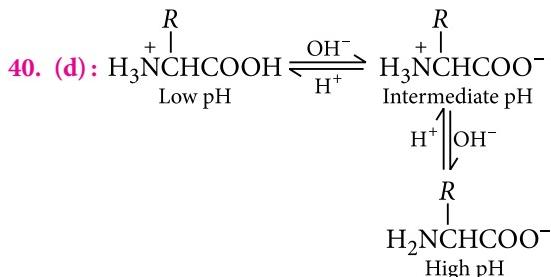
$$t_{1/2} = \frac{k'}{a^2} \Rightarrow t_{1/2} \cdot a^2 = k'$$

[k' is a proportionality constant.]

Units of k for the first order reaction are independent of concentration units.

- 38. (b) :** Toluene gets activated most due to maximum hyperconjugation.

- 39. (a) :** LiCl and LiBr are covalent and hence their melting points are low. Amongst NaCl and NaI, NaCl has higher ionic character (because Cl^- is smaller than I^- ion) and hence has higher lattice energy than NaI. Therefore, NaCl has the highest melting point.



$$K_1 = \frac{[\text{H}_3\overset{+}{\underset{|}{\text{N}}} \text{CHCOO}^-][\text{H}^+]}{[\text{H}_3\overset{+}{\underset{|}{\text{N}}} \text{CHCOOH}]}$$

$$K_2 = \frac{[\text{H}_2\overset{+}{\underset{|}{\text{N}}} \text{CHCOO}^-][\text{H}^+]}{[\text{H}_3\overset{+}{\underset{|}{\text{N}}} \text{CHCOO}^-]}$$

$$\text{Thus, } K_1 K_2 = \frac{[\text{H}_2\overset{+}{\underset{|}{\text{N}}} \text{CHCOO}^-][\text{H}^+]^2}{[\text{H}_3\overset{+}{\underset{|}{\text{N}}} \text{CHCOOH}]}$$

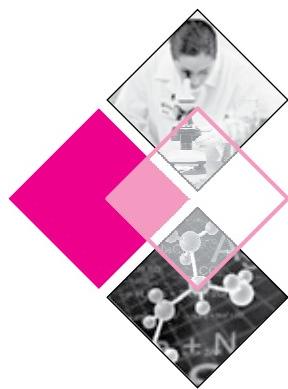
$$K_1 K_2 = [\text{H}^+]^2; \quad 2 \log [\text{H}^+] = \log K_1 + \log K_2$$

$$-2 \log [\text{H}^+] = -\log K_1 - \log K_2$$

$$2\text{pH} = \text{p}K_1 + \text{p}K_2$$

$$\text{or} \quad \text{pH} = (\text{p}K_1 + \text{p}K_2)/2$$





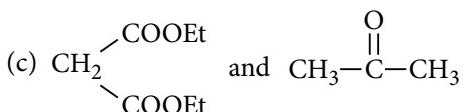
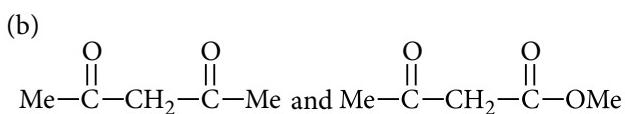
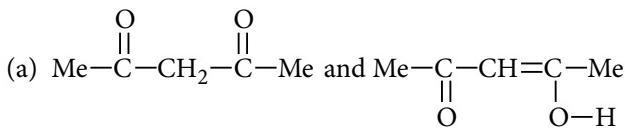
CONCEPT BOOSTER

Dear all !! Similar to the last article, this article also contains some good questions for competitive level. Keep practicing with time management. All the best for upcoming examinations. Take care!!

*Arunava Sarkar

ALDEHYDES, KETONES AND CARBOXYLIC ACIDS SINGLE CORRECT ANSWER TYPE

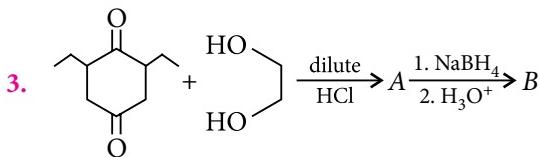
1. In which of the following pairs, the first one will have a higher enol content than the second one?



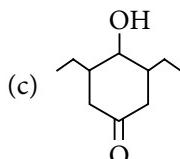
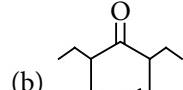
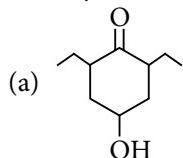
(d) Both (b) and (c).

2. Which of the following will undergo aldol condensation reaction?

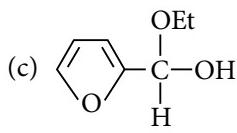
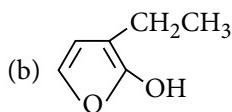
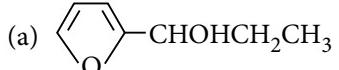
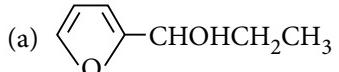
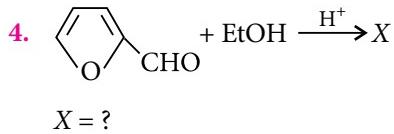
- (a) $(\text{CH}_3)_3\text{CCHO}$ (b) CCl_3CHO
 (c) PhCHO (d) $\text{CH}_3\text{CH}_2\text{CHO}$



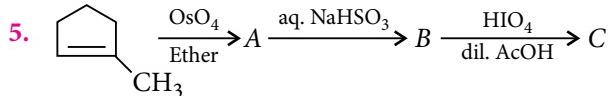
Identify 'B'.



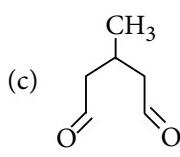
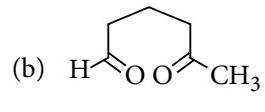
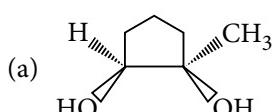
(d) None of these.



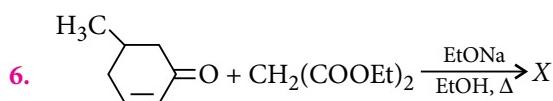
(d) None of these.



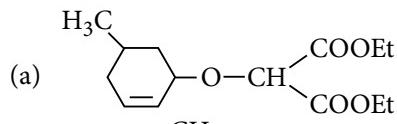
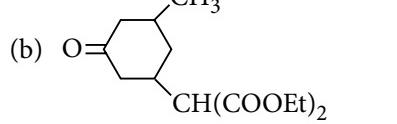
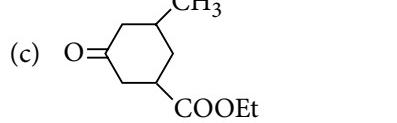
Identify 'C'.

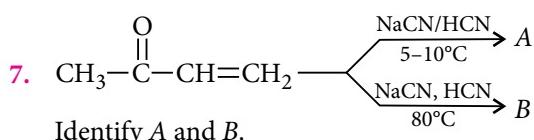


(d) None of these.

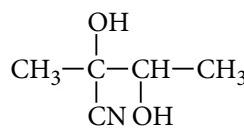
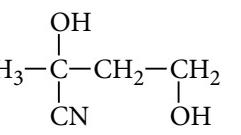
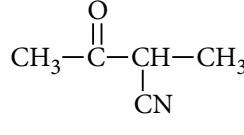
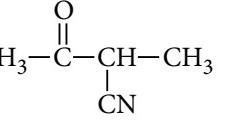
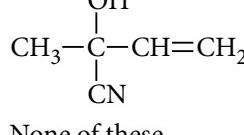
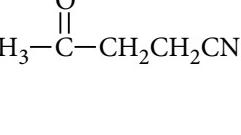


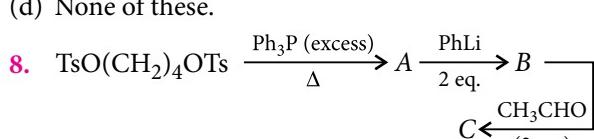
Identify X.

- (a) 
- (b) 
- (c) 
- (d) None of these.

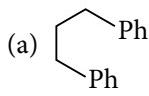
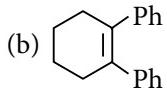


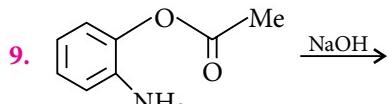
Identify A and B.

- | A | B |
|---|---|
|  |  |
|  |  |
|  |  |
- (d) None of these.

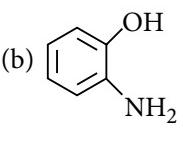
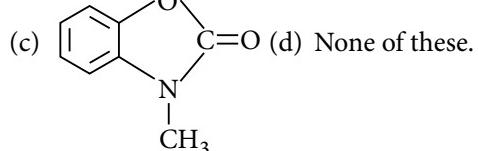


Identify 'C'.

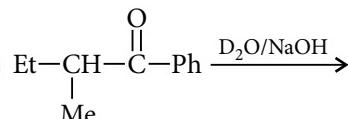
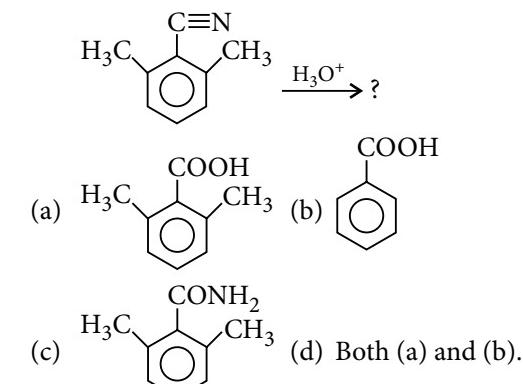
- (a) 
- (b) 
- (c) 
- (d) None of these.



Identify the product.

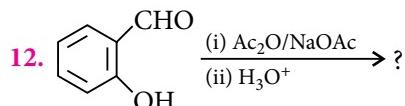
- (a) 
- (b) 
- (c) 
- (d) None of these.

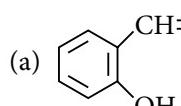
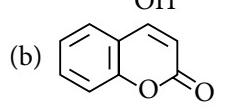
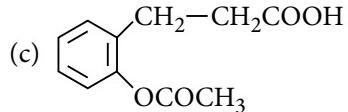
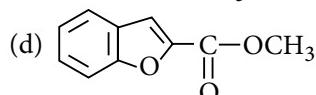
10. Identify the major product in the following reaction :

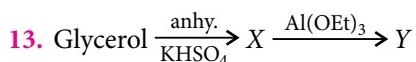


What is the possible observation?

- (a) An optically active compound is produced.
- (b) An optically inactive meso compound is produced.
- (c) An optically inactive racemic product is obtained.
- (d) Both (b) and (c).

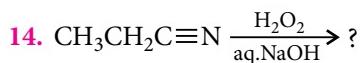


- (a) 
- (b) 
- (c) 
- (d) 

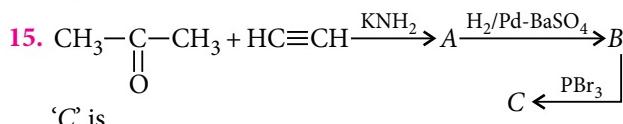


Identify (Y) in the above sequence of reactions.

- (a) $\text{CH}_2=\text{CH}-\text{CHO}$
- (b) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}=\text{CH}-\text{CHO}$
- (c) EtCHO
- (d) None of these.



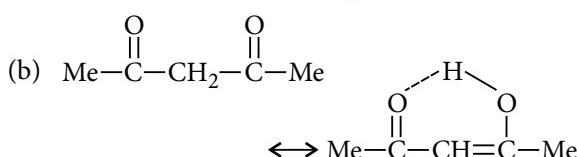
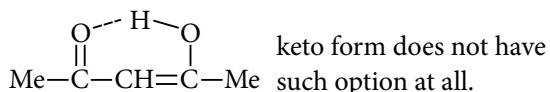
- (a) $\text{CH}_3\text{CH}_2-\underset{\text{O}}{\overset{\parallel}{\text{C}}}-\text{NH}_2$
- (b) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\underset{\text{O}}{\overset{\parallel}{\text{C}}}-\text{NH}_2$
- (c) $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$
- (d) None of these.



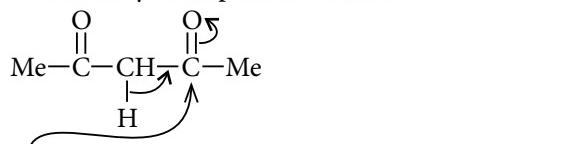
- (a) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{C}\equiv\text{C}-\text{Br}$
- (b) $\text{CH}_3-\underset{\text{CH}_3}{\text{C}}=\text{CH}-\underset{\text{Br}}{\text{CH}_2}$
- (c) $\text{CH}_3-\underset{\text{CH}_3}{\text{CH}}-\text{CH}_2-\underset{\text{Br}}{\text{CH}}-\text{CH}_3$
- (d) None of these.

SOLUTIONS

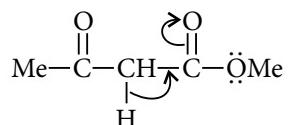
1. (d): (a) Enol form is stabilized through the intramolecular H-bonding i.e., chelation.



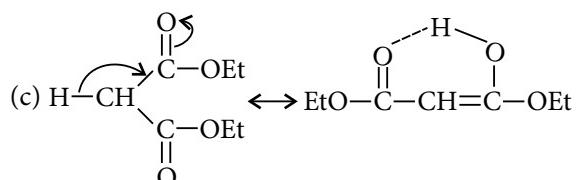
This actually takes place as below :



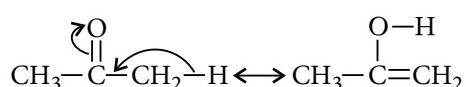
[A +ve charge is created here and the adjacent -Me does not disturb the +ve charge much. This is why adjacent H becomes acidic.]



[—OMe is highly electron donating through +R effect and the adjacent H becomes less acidic as the +ve charge on the carbon atom is destroyed.] So its enol content is not that high.

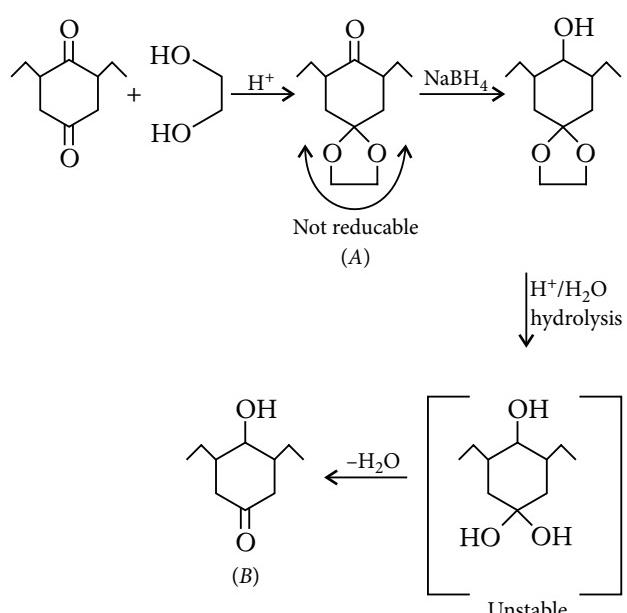


[—OEt is electron donating but still H-bonding as a stabilizing factor is present.]

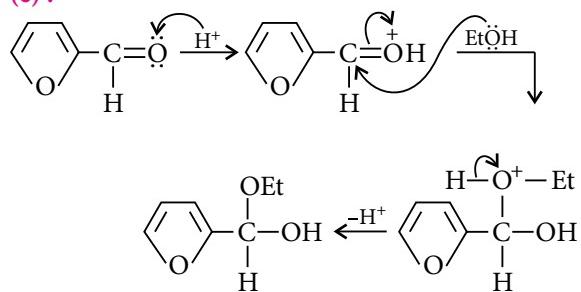


[No stabilizing factor is present here.]

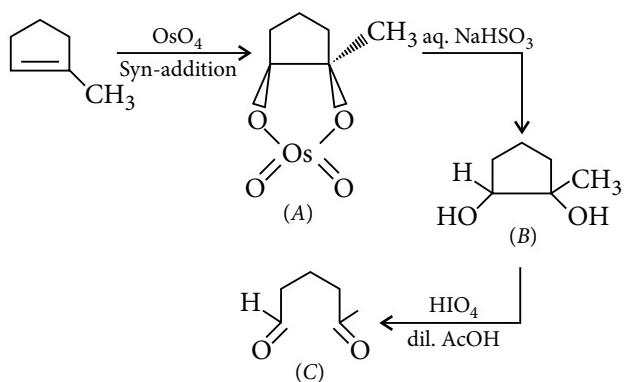
2. (d): Except $\text{CH}_3\text{CH}_2\text{CHO}$, none of the compounds is having α -H.
3. (c): It is based on the concept of protecting the carbonyl group. Due to the presence of two bulky ethyl groups, acetal formation takes place with another carbonyl group which is sterically free.



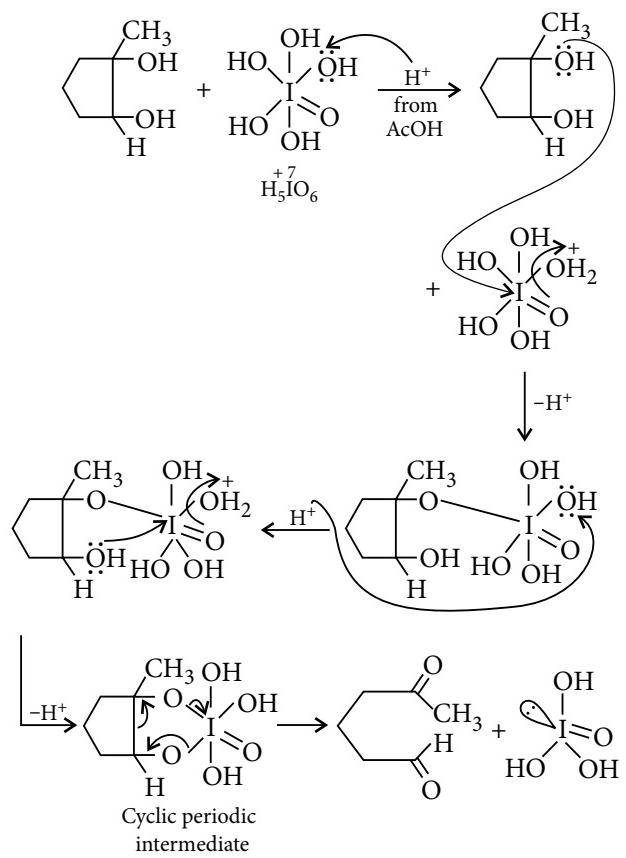
4. (c) :



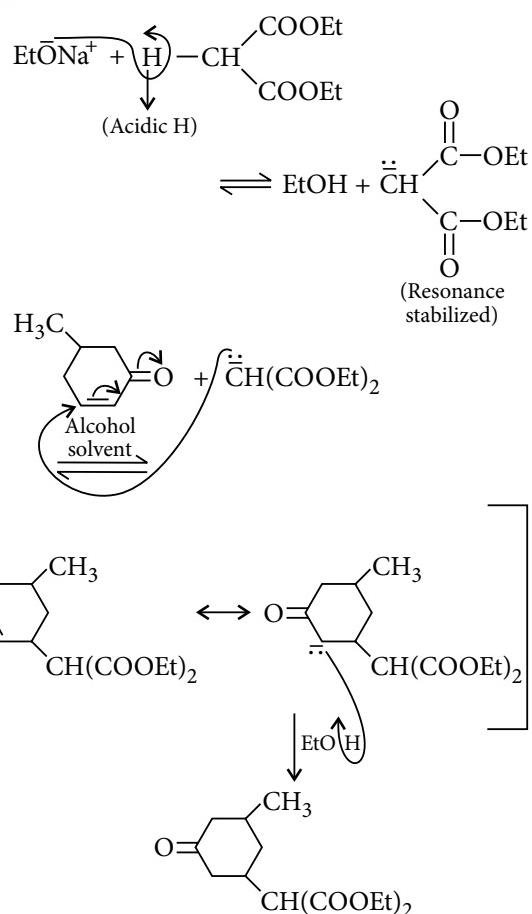
5. (b) :



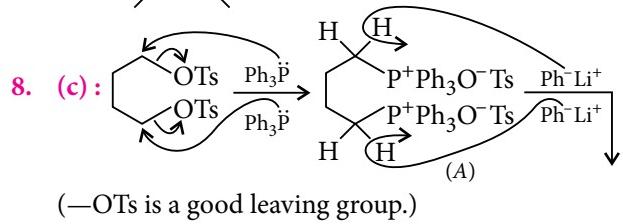
Working principle of HIO_4 is as follows :



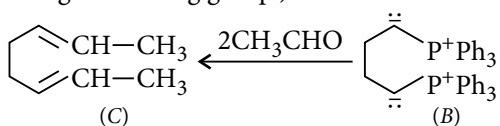
6. (b) : This is a Michael addition reaction.



7. (c) : The concept is based on thermodynamically and kinetically controlled reaction. When the temperature is lower, reaction is irreversible and kinetically controlled. So, due to more polarity of $\text{C}=\text{O}$ bond, addition takes place across $\text{C}=\text{O}$. When the temperature is higher, the reaction is reversible and hence thermodynamically controlled. $\text{C}=\text{O}$ is thermodynamically more stable than $\text{C}=\text{C}$ hence, addition takes place across $\text{C}=\text{C}$.

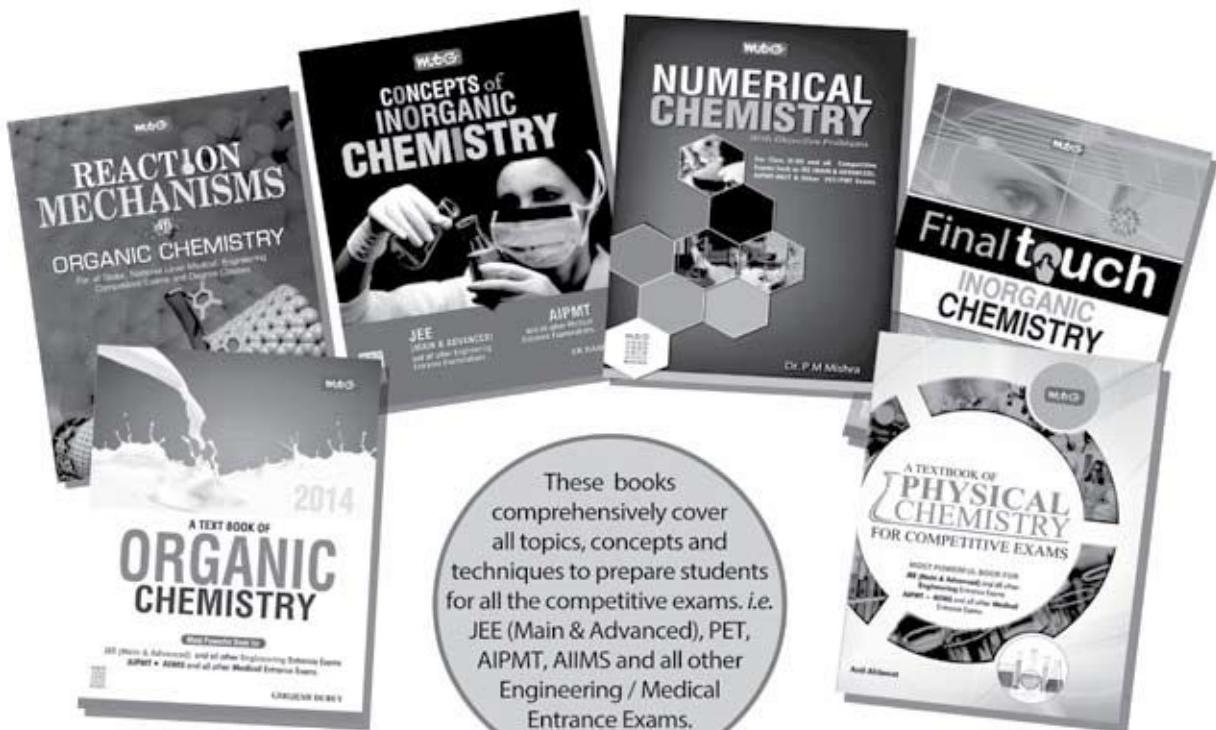


($-\text{OTs}$ is a good leaving group.)





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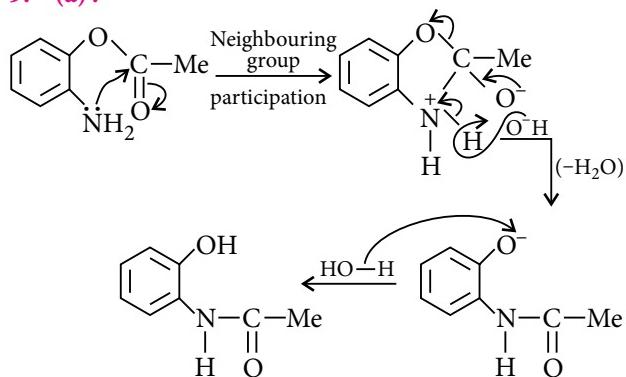
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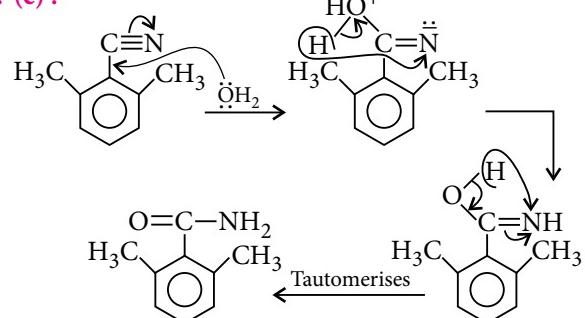
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9. (a):

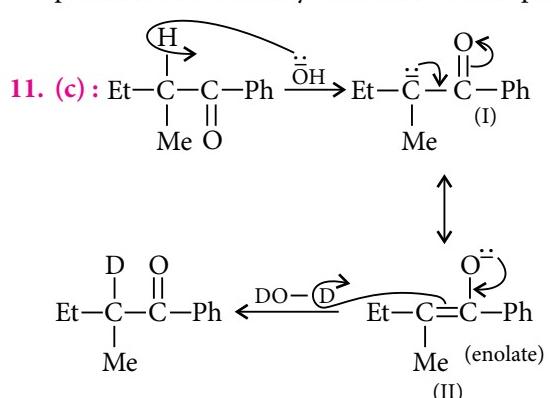


10. (c):



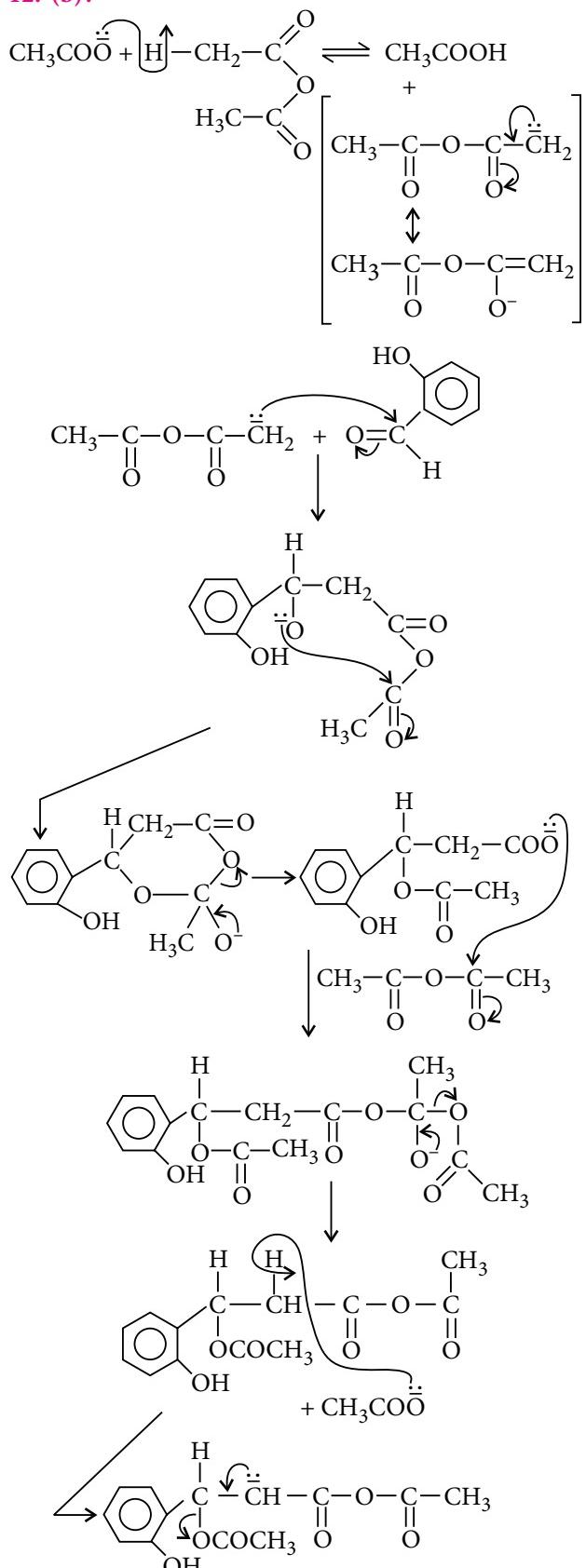
At first $-C\equiv N$ is linear and therefore it can undergo attack by H_2O molecule. After this no more attack is possible because of the steric reason at *ortho* positions. It is to be noted that it was possible in case of $-C\equiv N$ and not in $\begin{matrix} O \\ || \\ -C-NH_2 \end{matrix}$ because of the difference in their sizes. $\begin{matrix} O \\ || \\ -C-NH_2 \end{matrix}$ is quite

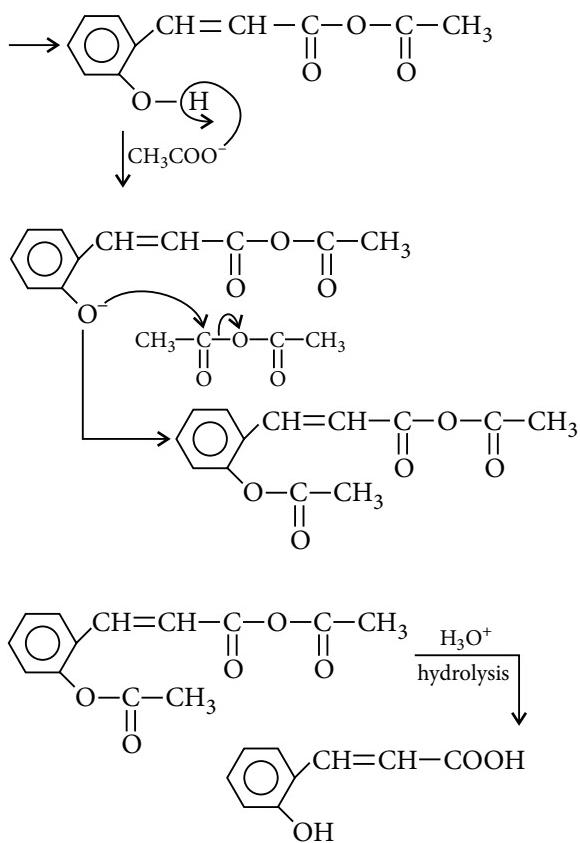
large and therefore steric hindrance comes into play. This is why further hydrolysis of amide is not possible. So, ultimately amide is the main product.



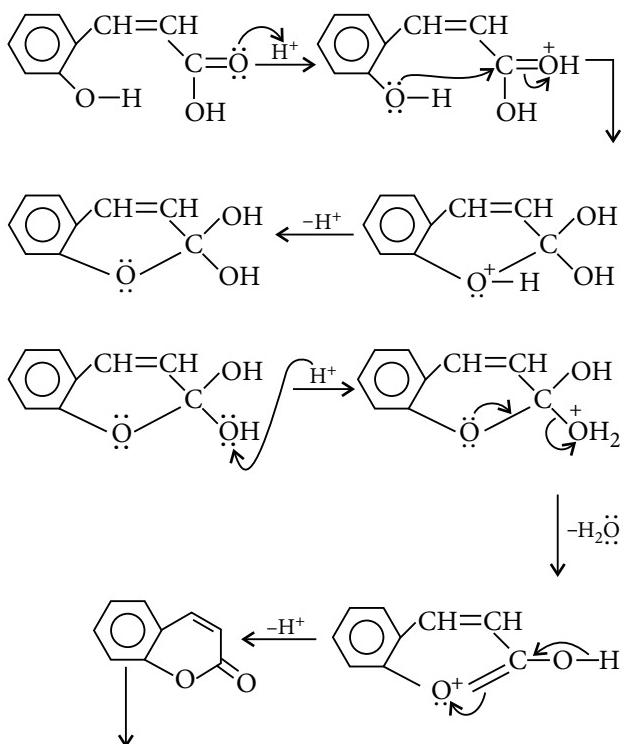
On (I), attack of D^+ takes place equally from both the sides hence racemic mixture, (\pm) -EtCD(Me)COPh is obtained.

12. (b):



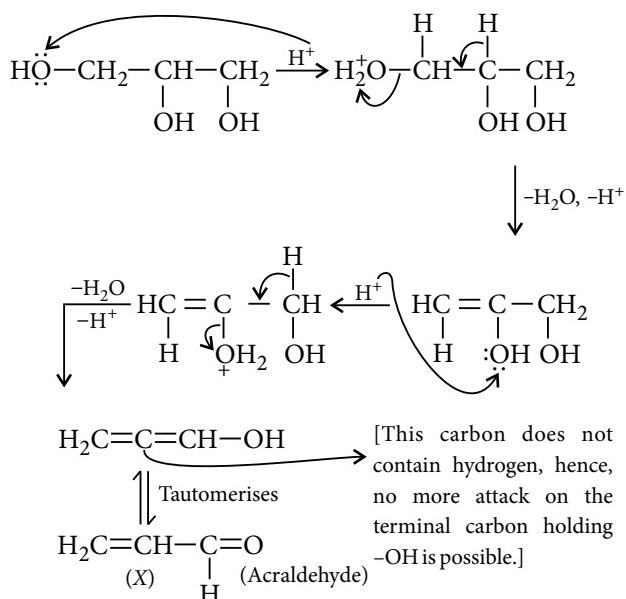


Now, a ring closure will take place as below :



[This compound is known as coumarin]

13. (d): KHSO_4 is an acidic salt.

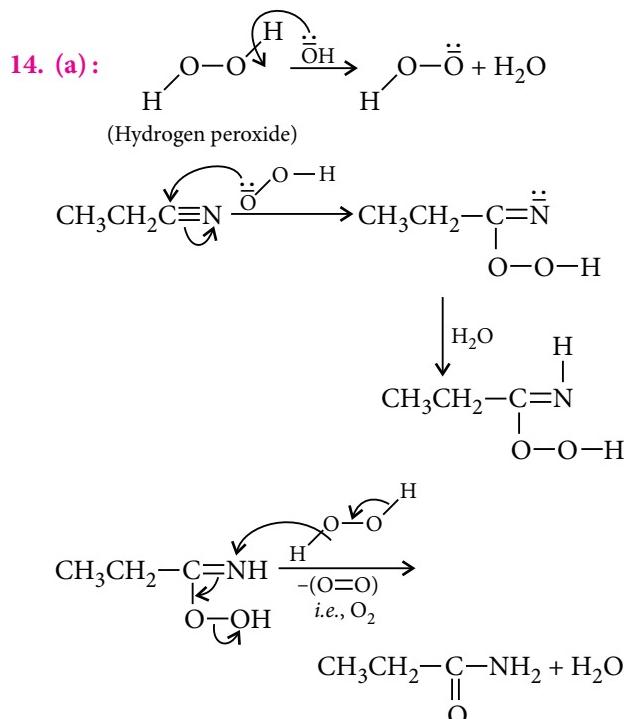
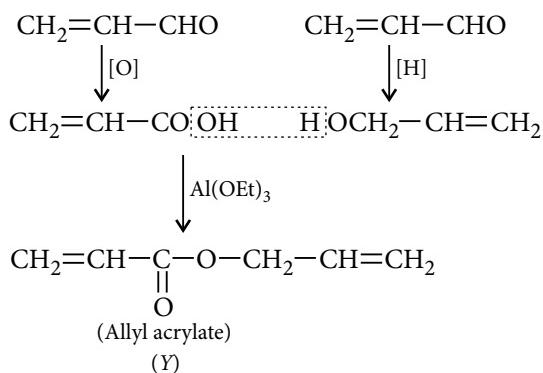


Al(OEt)_3 helps to serve the purpose of Tischenko reaction. So, short cut process of getting the product is, reduce one aldehyde (acraldehyde) and oxidise another acraldehyde and then form ester.

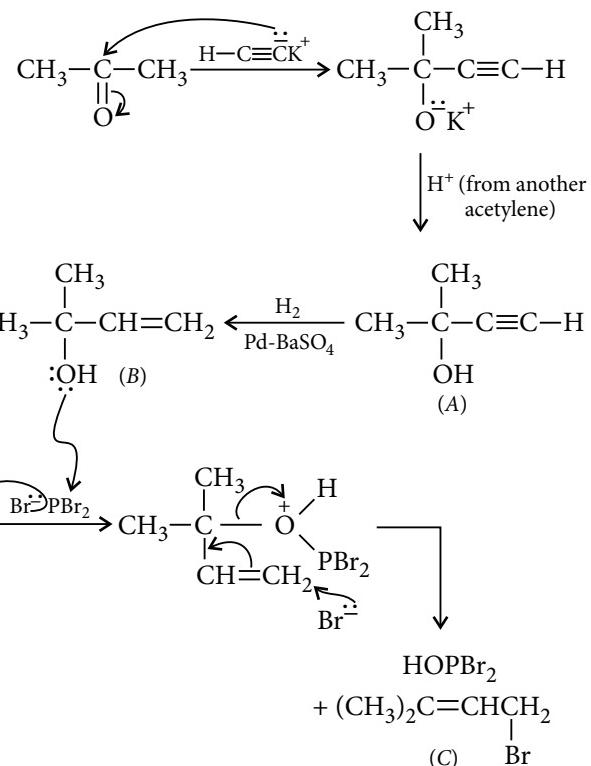
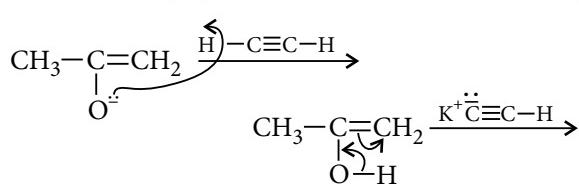
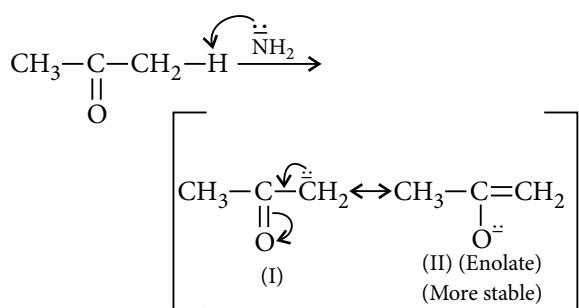
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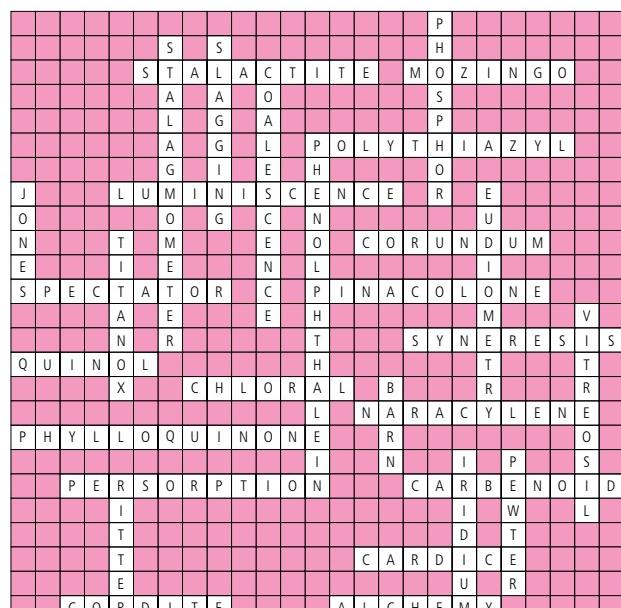
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15. (b): KNH_2 has $\ddot{\text{N}}\text{H}_2$ which is a good base. $\ddot{\text{N}}\text{H}_2$ abstracts a H^+ from CH_3COCH_3 as CH_3COCH_3 is more acidic than $\text{HC}\equiv\text{CH}$.



SOLUTIONS TO APRIL 2015 CROSSWORD



Winners of April 2015 Crossword

- Somya Aggarwal (Odisha)

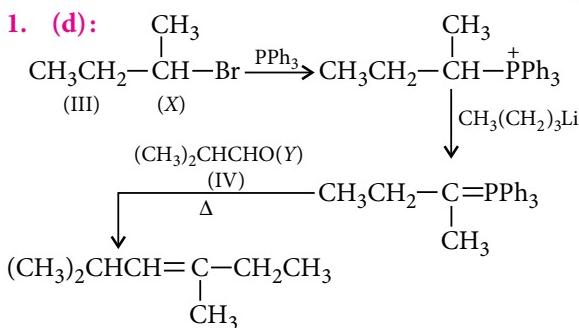
- Divyam A., Udupi (Karnataka)

Sender of March 2015 Crossword

- Shakkira C.K. (Kerala)

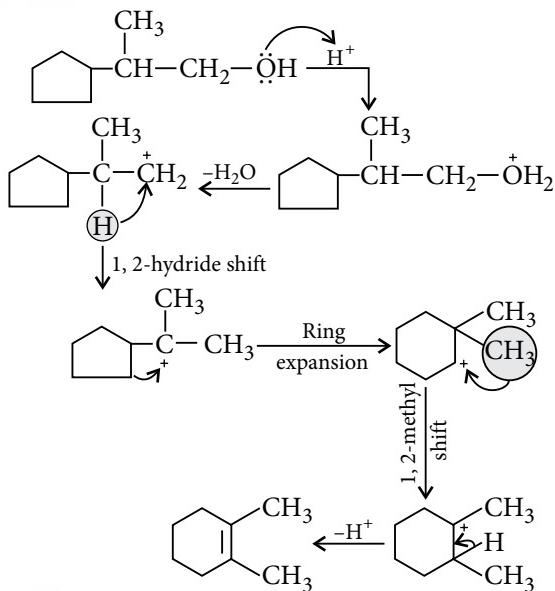
CHEMISTRY MUSING

SOLUTION SET 21



2. (b)

3. (c) :



4. (d)

5. (a) : Weight of LPG originally present = $29 - 14.8 = 14.2 \text{ kg}$

Weight of LPG present after use = $23.2 - 14.8 = 8.4 \text{ kg}$

Since volume is constant,

$PV = nRT$, Pressure = 2.5 atm

$$\frac{P_1}{P_2} = \frac{n_1}{n_2} = \frac{\frac{w_1}{M}}{\frac{w_2}{M}} = \frac{w_1}{w_2} \quad \text{or} \quad \frac{2.5}{P_2} = \frac{14.2}{8.4}$$

$$\Rightarrow P_2 = \frac{2.5 \times 8.4}{14.2} = 1.48 \text{ atm}$$

Weight of used gas = $14.2 - 8.4 = 5.8 \text{ kg}$

$$\text{Moles of gas} = \frac{5.8 \times 10^3}{58} = 100 \text{ mol}$$

[Molecular mass of *n*-butane = 58]

At normal conditions, $P = 1 \text{ atm}$,

$$T = 273 + 27 = 300 \text{ K}$$

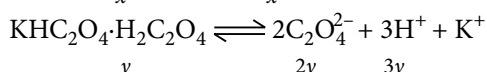
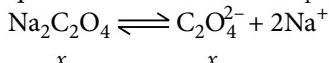
$$\text{As, } V = \frac{nRT}{P} = \frac{100 \times 0.082 \times 300}{1} = 2460 \text{ dm}^3$$

Hence, $V = 2.46 \text{ m}^3$

6. (c) : Let $\text{Na}_2\text{C}_2\text{O}_4(A)$ be $= x \text{ mol}$
and $\text{KHC}_2\text{O}_4 \cdot \text{H}_2\text{C}_2\text{O}_4 = y \text{ mol}$
Let volume of each titre = $V \text{ mL}$

$$\text{Moles of NaOH used} = \frac{V \times 0.1}{1000} = 10^{-4} V$$

and equivalent moles of KMnO_4 used = $10^{-4} V$



Thus, $[\text{H}^+]$ in mixture = $3y$

and $[\text{C}_2\text{O}_4^{2-}]$ in mixture = $(x + 2y)$

Equivalents of H^+ = Equivalents of NaOH

$$3y = 10^{-4} V$$

... (i)

Equivalents of $\text{C}_2\text{O}_4^{2-}$ which is oxidised to CO_2 =

Equivalents of MnO_4^- which is reduced to Mn^{2+} =

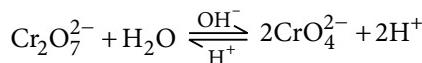
$$2(x + 2y) = 5 \times 10^{-4} V \quad \dots \text{(ii)}$$

$$\text{On dividing eqns. (ii) by (i) we get } \frac{(x + 2y)}{3y} = \frac{5}{2}$$

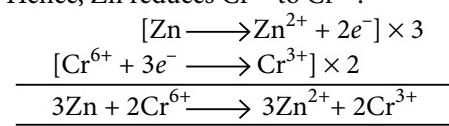
$$\frac{x}{3y} + \frac{2}{3} = 2.5 \Rightarrow \frac{x}{y} + 2 = 7.5 \Rightarrow \frac{x}{y} = 7.5 - 2 = 5.5.$$

$$\text{Thus, ratio} = \frac{x}{y} = \frac{5.5}{1}$$

7. (d) : Generally chromate ions get converted to dichromate ions only in acidic medium. Here, CO_2 dissolves in water to form H_2CO_3 and H_2CO_3 being weakly acidic is responsible for the conversion of CrO_4^{2-} to $\text{Cr}_2\text{O}_7^{2-}$.



8. (b) : Cr^{6+} is orange in colour while Cr^{3+} is green.
Hence, Zn reduces Cr^{6+} to Cr^{3+} .



9. (1) : HIO_4 is a specific reagent for cleavage of $\text{C}-\text{C}$ bond if two $-\text{OH}$ groups or $-\text{OH}$ and $-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-$ group or only $-\overset{\text{O}}{\underset{\parallel}{\text{C}}}-$ groups are present at adjacent carbons.

10. (3)

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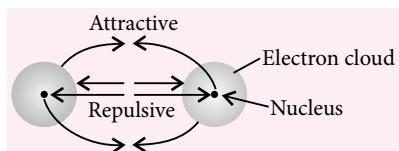
The best questions and their solutions will be printed in this column each month.

Q1. Though electrons repel each other still they make strong covalent bonds. Why?

Suraj Gohel (J.N.V., Rajkot)

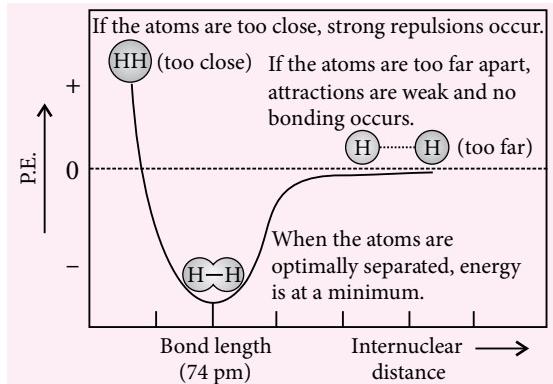
Ans. A covalent bond is formed when two atoms share electrons between them.

The two positively charged nuclei repel each other and the two negatively charged electrons repel each other, but each nucleus attracts both electrons.



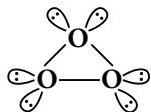
The nucleus-electron attractions are greater than the nucleus-nucleus and electron-electron repulsions resulting in a net attractive force that binds the atoms together.

If the attractive forces are stronger than the repulsive forces- *a covalent bond is formed*, with the two atoms joined together and the two shared electrons occupying the region between the nuclei. The magnitude of the various attractive and repulsive forces between nuclei and electrons in a covalent bond depends on how close the atoms are.



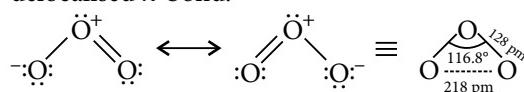
Greater the amount of energy released (more negative energy) greater is the stability of bond formed. Hence electrons do repel each other, but there are also nuclei attracting those electrons which negate the effects of repulsion.

Q2. Why we cannot write the structure of ozone like the one given below?



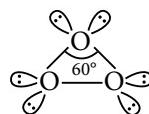
S.Majumdar, Howrah (W.B.)

Ans. Angular or bent form of ozone consists of three oxygen atoms with sp^2 hybridisation and bond angle 116.8° . Due to resonance, it also has delocalised π -bond.



Canonical forms of bent ozone

According to Baeyer Strain Theory, the three-membered ring in cyclic ozone is very unstable due to 'angle strain' which means the electron pairs in the bonds are very close together and therefore repel each other very strongly.

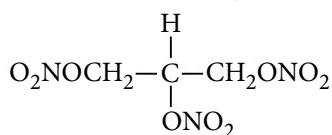


Hence, the cyclic form of ozone is slightly less stable than the angular or bent form with a 56.8° deviation.

Q3. Why is nitroglycerin explosive in nature?

Aditi Patil, Pune (M.H.)

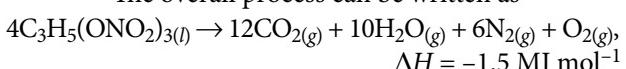
Ans. Nitroglycerin is a dense and oily liquid.



The molecule is explosive for following reasons :

1. Nitroglycerin molecule contains three nitrate groups (act as powerful oxidising agents) bound directly to a glycerol fragment (which acts as a fuel).
2. The decomposition of nitroglycerin is highly exothermic.

The overall process can be written as-



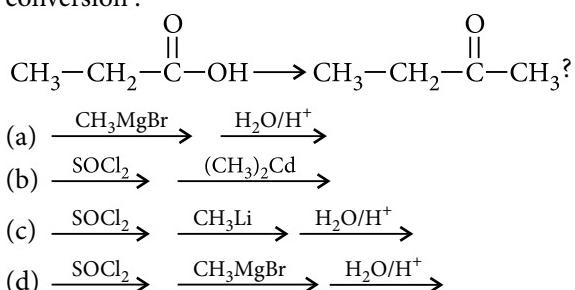
The reaction releases an enormous amount of heat because many strong bonds in the gaseous product molecules replace the fewer, weaker bonds in nitroglycerin.



OLYMPIAD PROBLEMS



1. Which reaction sequence is preferred for the conversion :



2. Among the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambient conditions is
- (a) $\text{CH}_3(\text{CH}_2)_{15}\text{N}^+(\text{CH}_3)_3\text{Br}^-$
 (b) $\text{CH}_3(\text{CH}_2)_{11}\text{OSO}_3^-\text{Na}^+$
 (c) $\text{CH}_3(\text{CH}_2)_6\text{COO}^-\text{Na}^+$
 (d) $\text{CH}_3(\text{CH}_2)_{11}\text{N}^+(\text{CH}_3)_3\text{Br}^-$

3. Doping Se with As would produce a/an _____ semiconductor with _____ conductivity compared to pure Se.
- (a) *n*-type, increased (b) *n*-type, decreased
 (c) *p*-type, increased (d) *p*-type, decreased

4. After alkalisng the solution of $\text{S}_2\text{O}_3^{2-}$ with NaOH and then adding KCN followed by boiling, we get a radical in the solution that gives blood red colour with FeCl_3 solution. The radical is
- (a) SCN^- (b) NCS^-
 (c) S^{2-} (d) CH_3COO^-

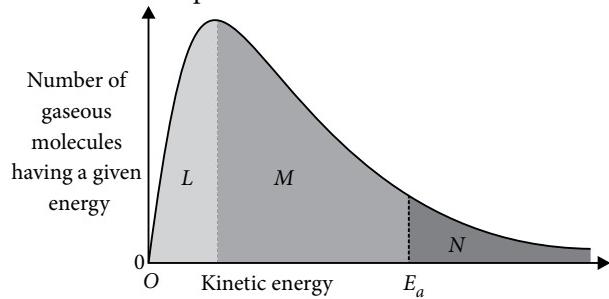
5. Which of the following statements describes the first step in the mechanism of the aldol condensation?
- (a) The carbonyl oxygen of one aldehyde attacks the carbonyl carbon of another.
 (b) The carbonyl oxygen is protonated by the base ion.
 (c) An α -hydrogen is abstracted by the base to form an enolate anion.
 (d) The α -hydrogen is abstracted by an acid to form an enolate anion.

6. The heat energy required to melt 1.0 g of ice at 0°C is 335 J. If one ice cube has a mass of 58.0 g, and you have 12 ice cubes, what quantity of energy is required to melt all of the ice cubes to form liquid water at 0°C ?

(a) 2,33,160 J (b) 2,33,106 J
 (c) 2,33,016 J (d) 2,33,610 J

7. In Haworth projection, the α -anomer of glucose contains the $-\text{OH}$ group
- (a) above the plane of ring
 (b) below the plane of ring
 (c) in the plane of ring pointing outwardly
 (d) inside the plane of ring pointing inwardly.

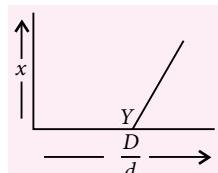
8. The Boltzmann distribution shows the number of molecules having a particular kinetic energy at constant temperature.



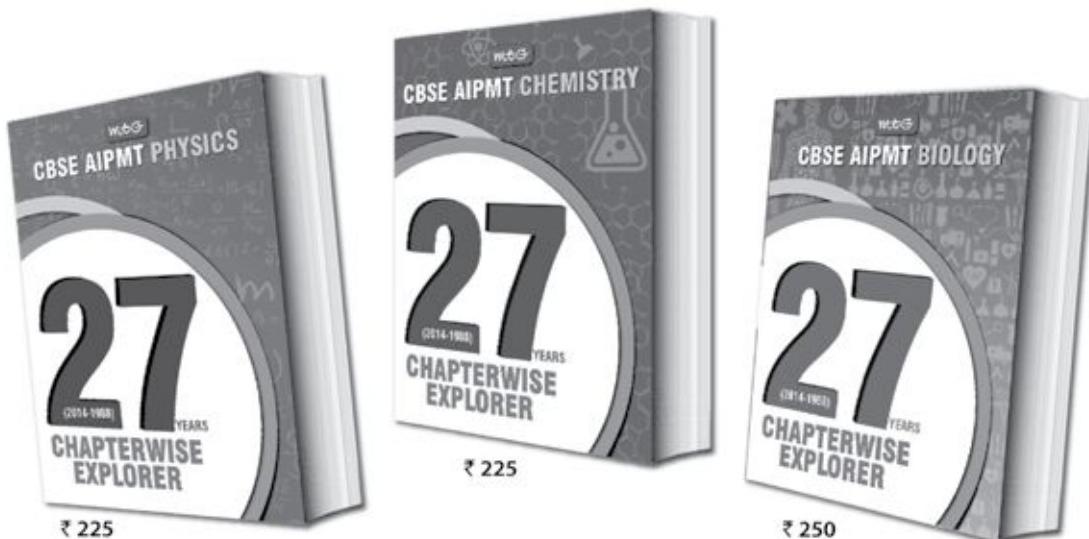
If the temperature is decreased by 10°C , what happens to the size of the areas labelled L, M and N?

L	M	N
(a) Decreases	Decreases	Decreases
(b) Decreases	Increases	Decreases
(c) Increases	Decreases	Decreases
(d) Increases	Decreases	Increases

9. The electron-domain geometry and the molecular geometry of a molecule of the general formula, AB_n will always be the same if



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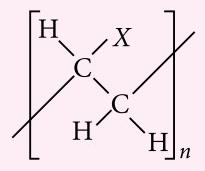
*Application to read QR codes required

20. Plastic bottles for 'fizzy drinks' are made from a polymer with the following structure:

The ability of the polymer to prevent escape of carbon dioxide through the wall of the bottle depends on the ability of the group X to form hydrogen bonds with the carbon dioxide in the drink.

The group X which best prevents loss of carbon dioxide is

- (a) Cl
- (b) CN
- (c) COOCH_3
- (d) OH



21. In an irreversible process taking place at constant T and P and in which only pressure-volume work is being done, the change in Gibbs free energy (dG) and change in entropy (dS), satisfy the criteria

- (a) $(dS)_{V,E} < 0, (dG)_{T,P} < 0$
- (b) $(dS)_{V,E} > 0, (dG)_{T,P} < 0$
- (c) $(dS)_{V,E} = 0, (dG)_{T,P} = 0$
- (d) $(dS)_{V,E} = 0, (dG)_{T,P} > 0$

22. Which of the following reactions takes place in zone of fusion in the blast furnace during the extraction of iron?

- (a) $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
- (b) $\text{CO}_2 + \text{C} \longrightarrow 2\text{CO}$
- (c) $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2$
- (d) $\text{Fe}_2\text{O}_3 + 3\text{CO} \longrightarrow 2\text{Fe} + 3\text{CO}_2$

23. _____ will not yield secondary amine.

- (a) Reduction of aldoxime
- (b) Reduction of carbylamines
- (c) Reduction of Schiff's base
- (d) Reduction of N -methyllethanamide

24. In the Michael reaction, addition to the α, β -unsaturated carbonyl compound occurs in a

- (a) 1,3-fashion
- (b) 1,4-fashion
- (c) 1,5-fashion
- (d) 1,2-fashion.

25. When a non-volatile solute is added to a volatile solvent, the vapour pressure of solution _____, the boiling point _____, the freezing point _____, and the osmotic pressure across a semipermeable membrane _____.

- (a) decreases, increases, decreases, decreases
- (b) increases, increases, decreases, increases
- (c) increases, decreases, increases, decreases
- (d) decreases, increases, decreases, increases

26. K_2CS_3 can also be called potassium

- (a) sulphocyanide
- (b) thiocarbide
- (c) thiocarbonate
- (d) thiocyanate.

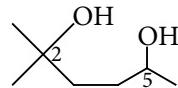
27. Which of these polymers could be readily prepared by condensation polymerisation?

- (a)
- (b)
- (c)
- (d)

28. The compound $\text{CH}_3-\underset{\text{CH}_3}{\overset{|}{\text{C}}}=\text{CH}-\text{CH}_3$ on reaction

- with NaIO_4 or on boiling with KMnO_4 produces
- (a) $\text{CH}_3\text{COCH}_3 + \text{CH}_3\text{COOH}$
 - (b) $\text{CH}_3\text{COCH}_3 + \text{CH}_3\text{OH}$
 - (c) $\text{CH}_3\text{CHO} + \text{CO}_2$
 - (d) only CH_3COCH_3

29. Which of the following is true for the following diol?



- (a) —OH group at C2 is more basic than that at C5.
- (b) —OH group at C2 is more acidic than that at C5.
- (c) Both —OH groups act as equally strong bases.
- (d) Both —OH groups act as equally strong acids.

30. Which of the following statements is true?

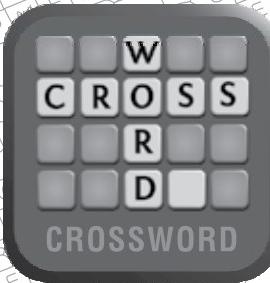
- (a) The electron affinity of bromine is greater than that of selenium.
- (b) The ionic radius of Fe^{2+} is smaller than that of Fe^{3+} .
- (c) The first ionization energy of phosphorus is less than that of sulphur.
- (d) The fourth ionization energy of boron is only slightly greater than the third ionization energy of the same element.

ANSWER KEYS

- | | | | | |
|---------|---------|---------|---------|---------|
| 1. (b) | 2. (a) | 3. (c) | 4. (a) | 5. (c) |
| 6. (a) | 7. (b) | 8. (c) | 9. (a) | 10. (a) |
| 11. (c) | 12. (b) | 13. (b) | 14. (c) | 15. (b) |
| 16. (d) | 17. (a) | 18. (a) | 19. (c) | 20. (d) |
| 21. (b) | 22. (b) | 23. (a) | 24. (b) | 25. (d) |
| 26. (c) | 27. (a) | 28. (a) | 29. (a) | 30. (a) |



CROSS WORD



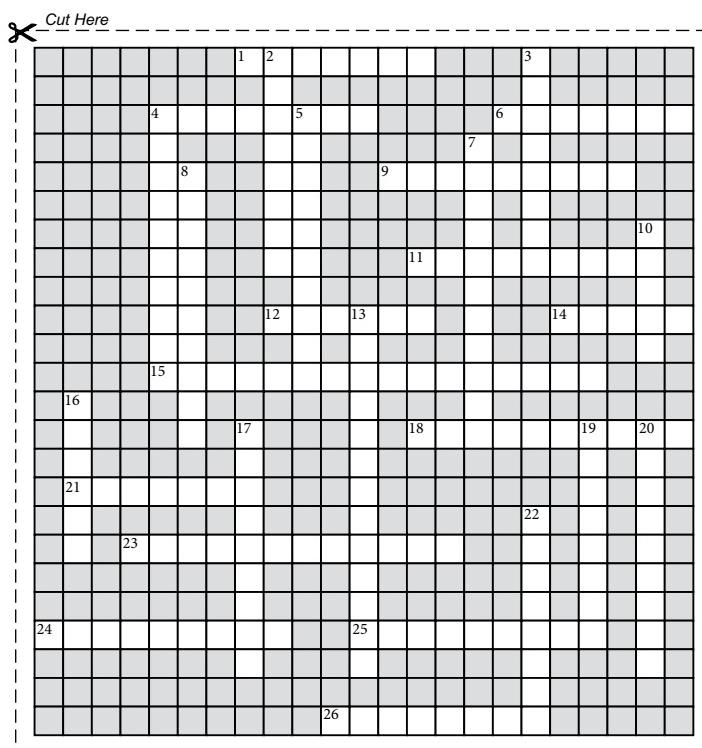
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ACROSS

1. The formation of more substituted alkene in an elimination reaction is in accordance with _____ rule. (7)
4. The formulation which reduces the rate at which urease decomposes urea. (8)
6. Lumps of pure metals found in earth. (7)
9. Solutions of two electrolytes having same concentrations of common ion, which show no change in degree of dissociation of either of the electrolytes on mixing. (9)
11. An antiseptic and germicide used for washing wounds, teeth and ears. (9)
12. Method used for the estimation of alkoxy groups. (6)
14. Industrial name of Na_2O_2 . (5)
15. The electricity produced when mechanical stress is applied on polar crystals. (16)
18. Commercial name of PMMA. (10)
21. Lightest radioisotope. (7)
23. The separation of colloidal sol into two liquid phases. (12)
24. A throat lozenge obtained by mixing formaldehyde with lactose. (9)
25. A crystalline form of CaCO_3 . (9)
26. Solid compounds of carbon with elements other than hydrogen. (8)

DOWN

2. Rate of decay of a radioactive element. (8)
3. The reciprocal of the coefficient of viscosity. (8)
4. The process to separate two gases on the basis of difference in their densities and rates of diffusion. (9)
5. A tricyclic aromatic hydrocarbon obtained from green oil fraction of coal-tar. (10)



7. An anti-malarial drug which kills the parasites in blood. (11)
8. The lowest temperature at which an oil gives sufficient amount of vapours to form an explosive mixture with air. (10)
10. A polymeric hydride of aluminium. (5)
13. Common name of cetyl palmitate. (13)
16. An explosive mixture of NH_4NO_3 and TNT. (6)
17. The process of heating the steel to appropriate temperature and then cooling it rapidly. (9)
19. A poisonous gas obtained by the reaction of acetylene with AsCl_3 . (8)
20. Name of the scientist who named the gas 'ozone'. (9)
22. Nuclear species with definite atomic number and mass number. (8)



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